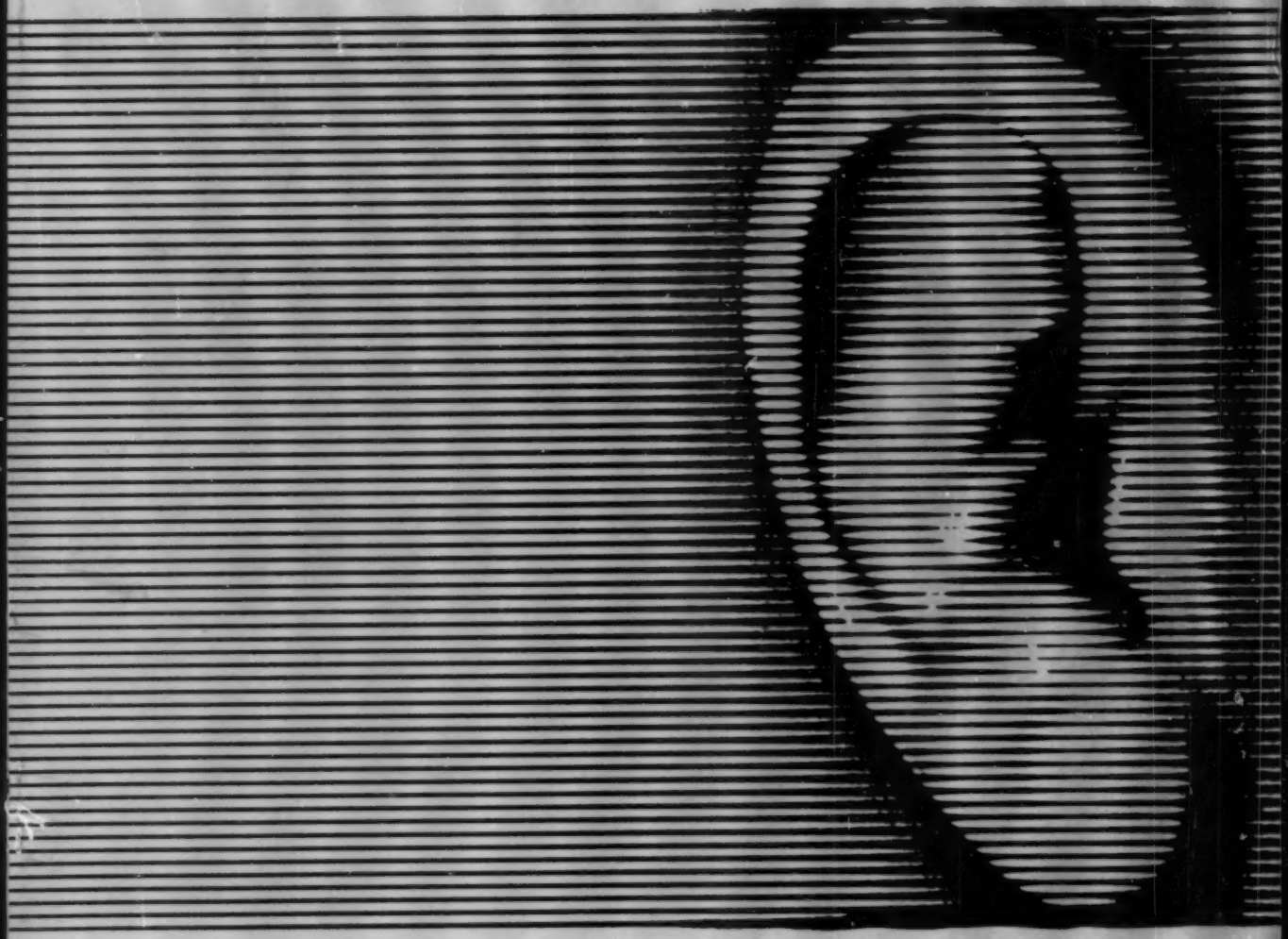
NOVEMBER 9, 1961

MACHINE DESIGN

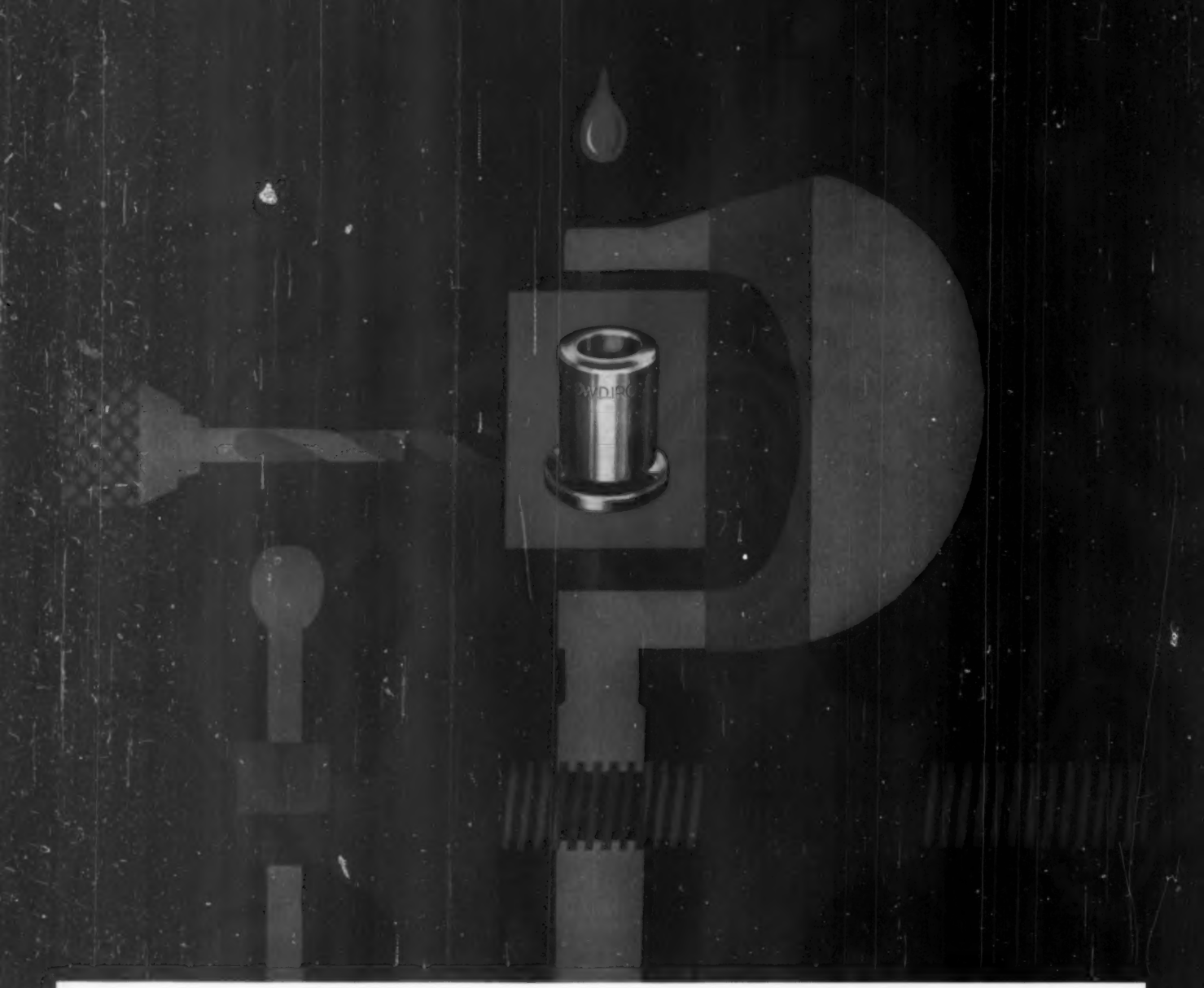
A PENTON PUBLICATION — BIWEEKLY



Audible Signals

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Circle 201 on Page 19



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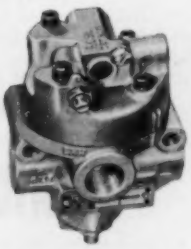
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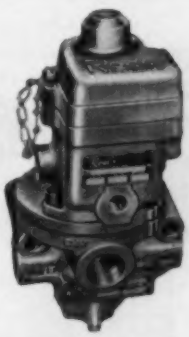
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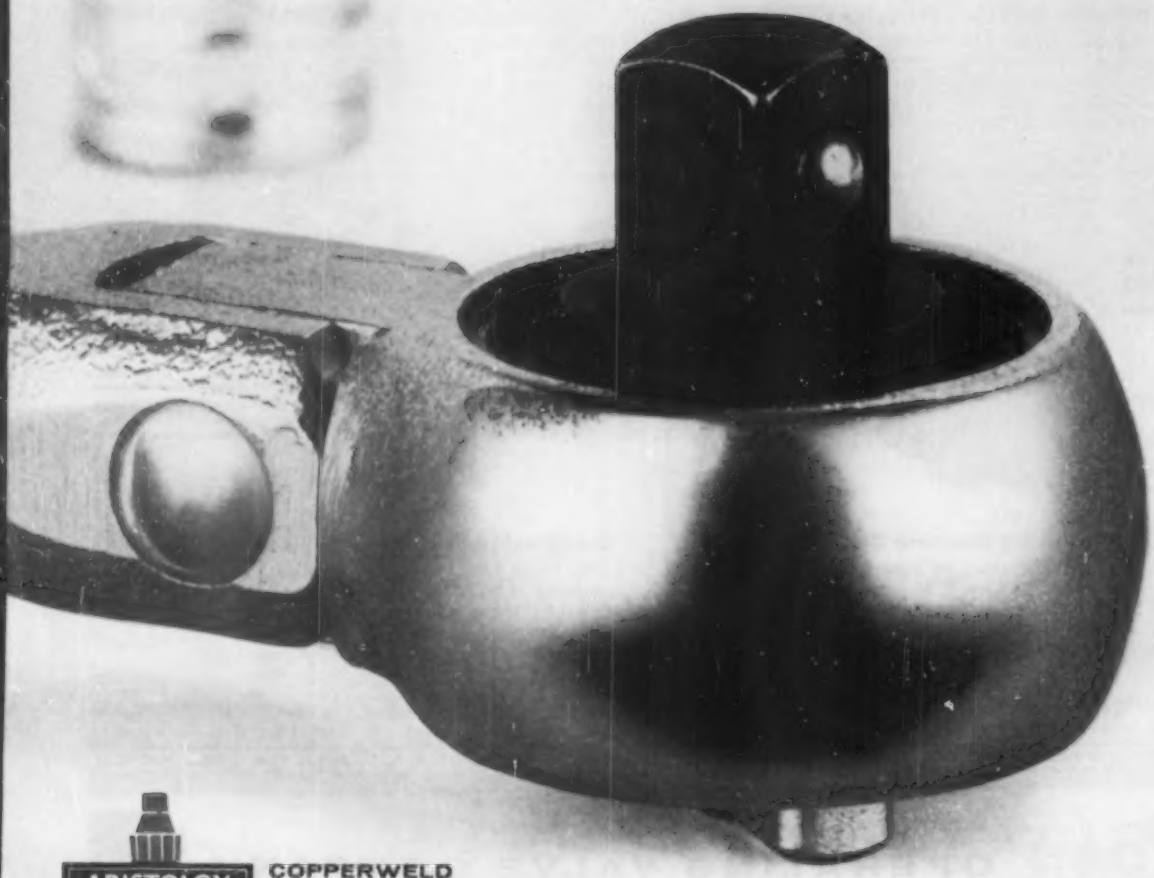
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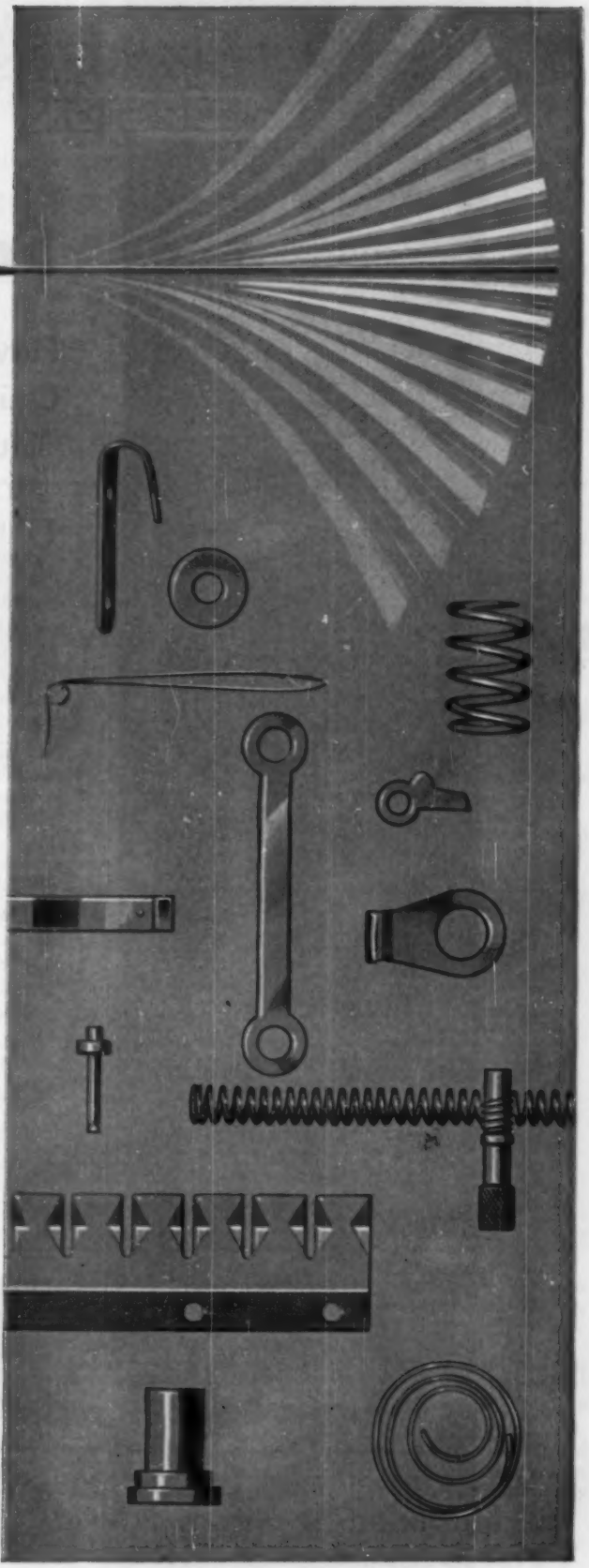
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DURAFLEX

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Here is a versatile new type of phosphor bronze. The superfine-grain structure of Duraflex provides a considerable improvement in fatigue life over regular phosphor bronze. An independently supervised laboratory test recently proved this. Three springs of regular Phosphor Bronze, 5% (A) took a permanent set at about 200,000 deflections and fractured at an average of *453,374* deflections. Four springs of DURAFLEX Superfine-Grain Phosphor Bronze, 5% (A) showed no permanent set, no loss of load and no breakage at *4,000,000* deflections.

This new, higher quality Anaconda phosphor bronze is now available in several standard phosphor bronze alloys—in strip metal up to 0.062″ thick and up to 14″ wide in all standard tempers, and in wire up to 3/16″ diameter. Duraflex strip is also available in long rolls.

Within the capabilities of size and alloy composition, Duraflex strip and wire can be applied to the innumerable uses for which conventional phosphor bronzes are employed, and in most instances provide longer and more efficient service. *Yet Duraflex sells for the same price as regular phosphor bronze in the same alloys and forms.*

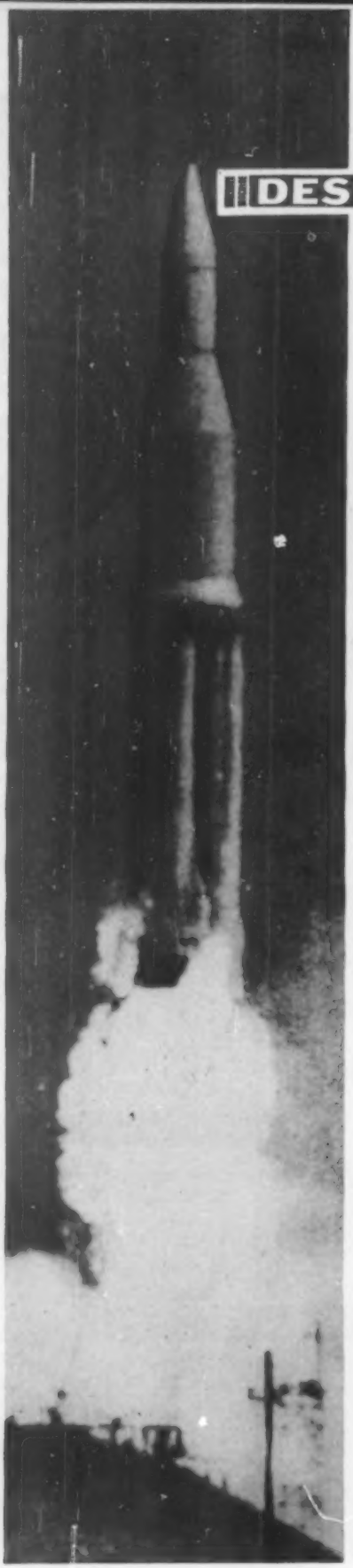
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Saturn Goes

Flawless First Flight Quiets Critics of "Clusters' Last Stand"

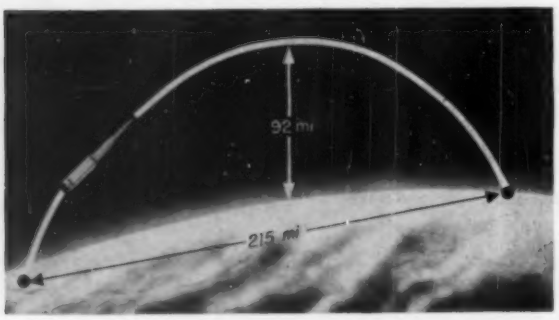
UNPRECEDENTED success of the Saturn launch marks the first milestone in the U. S. effort to explore the moon and planets. Flight tests of Saturn mated to the three-man Apollo moon capsule now seem assured to begin on schedule in 1964.

Saturn's flawless performance is probably unrivaled in U. S. rocketry. The 11-hour countdown proceeded without a single technical hitch, something that has never happened on a major missile firing, let alone a first test shot. "Clusters' last stand," as the eight-engine booster had been called by some critics, shows evidence of being as reliable as the elderly Redstone missile, another product of NASA's Marshall Space Flight Center, headed by Dr. Wernher Von Braun.

Start of a Three-Stage Program

The first operational Saturn, known as C-1, will consist of a maximum of three stages, S-I (launched last month), S-IV, and S-V. They will be tested during a ten-vehicle research and development flight-test program. In the first four firings, only the booster (S-1) will be live. In the next two, the booster and the second stage (S-IV) will be live. While the primary purpose of the first ten flights is to prove the vehicle, the last four flights, SA-7 through SA-10, will have secondary missions of testing early models of the Apollo Spacecraft. Following are descriptions of the Saturn stages:

S-I: The Saturn C-1 first stage (S-1) is powered by a cluster of eight Rocketdyne H-1 engines, each of



Fluid Power news

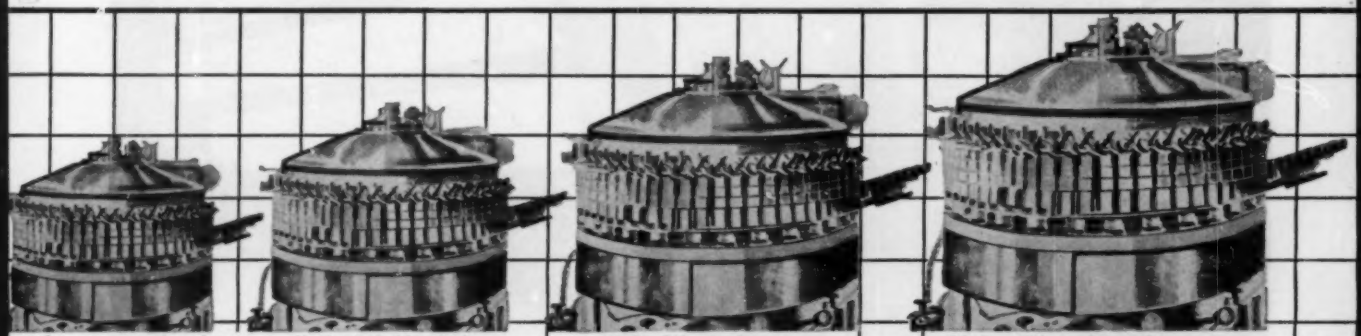
OILGEAR 40 Years of Fluid Power

Report No. 11,101 From Oilgear *Application-Engineering* Files

How OILGEAR HYTAC Drives Improve Filler-Closer Performance — Triple Output —

CUSTOMER: *A Large Food Machinery Manufacturer (Name withheld by request)*

DATA: This manufacturer called upon Oilgear to help solve the problem of producing a filling and closing machine that would exceed the mechanical drive limitations reached when the fill-close rate was increased from 150 to 360 12-oz cans per minute. *Summary of User Requests:* A fill-close rate of at least 425 12-oz cans per minute; accelerate to half speed in 2 seconds—to full speed in 5 seconds without jerky, jack rabbit starts that strain the equipment; reduce spillage and "deadheads"; decelerate to stop in 0.4 seconds; reduce costly losses due to under or overfilling; change speed instantly, easily—with remote control preferred; accurately hold any selected speed regardless of load or electric power variations—viscosity changes; impervious to daily sanitary washdowns; provide trouble-free, low-maintenance, continuous operation.



Average normal mechanical drive—150 12-oz cans per minute.

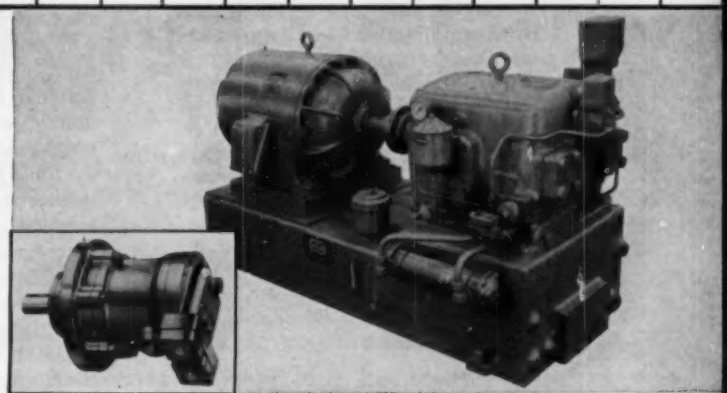
Mechanical drive limit—360 12-oz cans per minute.

1955—Oilgear heavy-duty, Size 20, Any-Speed HYTAC drive—to 600 12-oz cans per minute with improved performance.

1960 — Oilgear heavy-duty, Size 35, Any-Speed HYTAC drive—to 1200 12-oz cans per minute with improved performance.

OILGEAR SOLUTION #1 (1955) Oilgear heavy-duty, Size 20, Any-Speed HYTAC (hydraulic tachometer) drives provided the first step in meeting user requests. These drives on a 6-spindle closer and 60-spout filler smoothly accelerated to full speed in 2 seconds—decelerated to stop in 0.2 seconds; a new, high fill-close rate—to 600 12-oz cans per minute without machine redesign; held *any* preselected speed within ± 0.5% regardless of load, electric power variations or viscosity changes—assuring uniform fill; reduced spillage and conveyor jams. Oilgear heavy-duty HYTAC simplified machine design and reduced maintenance by eliminating slip clutches and electric brakes—and by providing hydraulic cushioning; hydro-dynamic braking; automatic, positive protection against starting and running overloads. Remote, space-saving pump and motor location and completely sealed, leak-tight system provided protection to daily, sanitary washdowns. Users liked this improved performance and speed . . . over 50 similar installations have been made. Some users, however, continued to request higher production rates—with all of HYTAC's advantages.

OILGEAR SOLUTION #2 (1960) Due to the proven ability of Oilgear application-engineered, heavy-duty, drive and control systems to help meet user demands, this manufacturer naturally turned to Oilgear for further engineering teamwork in meeting new, greater production requirements. *RESULT*—new, higher production filling-closing machines that TRIPLE original mechanical drive output—to 1200 12-oz cans per minute with all the same desirable features outlined in the previous installations. One important addition has been made . . . new user satisfaction.



This is the newest Oilgear Power-Pak for filler-closers—Oilgear heavy-duty, Size 35 HYTAC drive components. Unit can be remotely mounted and remotely controlled for new performance, new production speed, new accuracy.

Here is but one reason and proof why designers and builders of machinery turn to Oilgear . . . why users recognize and trust the name . . . why more and more this phrase is heard, "For the lowest cost per year—it's Oilgear!"

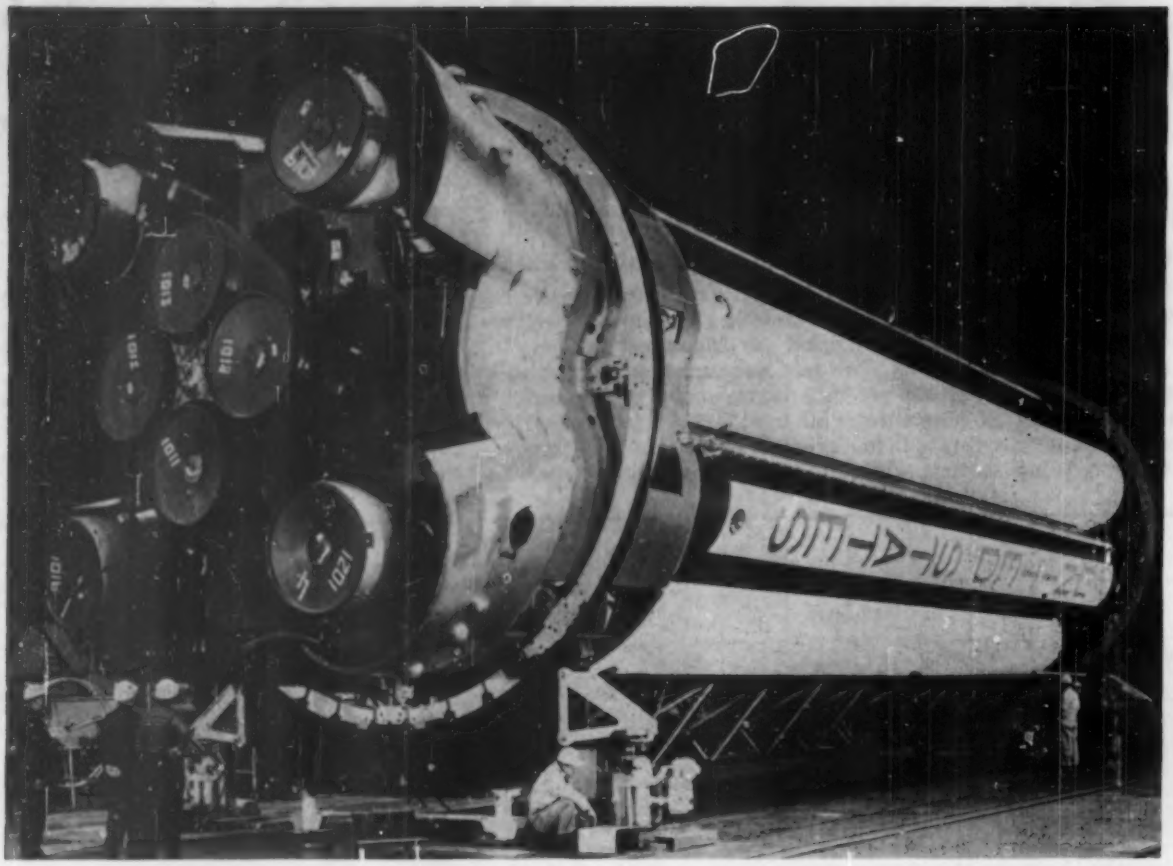
For practical solutions to YOUR linear or rotary drive and control problems, call the factory-trained Oilgear application-engineer in your vicinity. Or write, stating your specific requirements, directly to

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Eight H-1 engines, attached to an eight-legged thrust frame on the aft end of the vehicle, form two square patterns. The four inboard engines are rigidly attached and canted at 3 deg to the long axis of the booster. Outboard engines are canted at an angle of 6 deg and are mounted on gimbals. They can be turned through angles up to 7.5 deg to provide control of the vehicle during first-stage powered flight. Four inner engines are cut off at 111 sec after lift-off; the four outer engines at 117 sec. This prevents unacceptable oscillations which might occur if all engines shut down at once.

ROUND ONE

Saturn First-Flight Specifications

Height (ft)	162
Weight, fueled (lb)	925,000
Fuel (lb)	600,000
Diameter (ft)	21.5
Thrust (lb)	1,300,000
Altitude, max (mi)	92
Range (mi)	215
Speed, max (mph)	3700
Flight time (min)	8

which will ultimately produce 188,000 lb of thrust for a total of 1,500,000 lb. H-1s in the SA-1 launch were rated at 165,000 lb.

Rocketdyne's H-1 engine is an advanced and compact offspring of Jupiter and Thor IRBM engines. Selected because of its relative simplicity, early availability, and proven reliability, it burns RP-1 (kerosene) and liquid oxygen. Major changes incorporated in the H-1 for Saturn include a simplified start sequence using a solid-propellant gas generator, and location of the turbopump on the thrust chamber, below the gimbal block, so that flexible propellant feed lines to the engine carry only low-pressure propellant.

Nine separate tanks feed the eight engines. Clustered in a circle about a large center tank 105 in. in diameter are eight smaller tanks, each 70 in. in diameter. The center tank and four outer ones contain liquid oxygen; the remaining four outer tanks hold kerosene. Fuel tanks are pressurized by gaseous nitrogen carried in 48 fiber-glass spheres atop the tanks. Liquid-oxygen containers are pressurized with gaseous oxygen obtained by passing liquid oxygen through heat exchangers that are part of each engine package.

Fuel tanks and liquid-oxygen tanks are interconnected at their bases to maintain equal levels in all tanks during burning. In case one engine malfunctions and is cut off during flight, this arrangement also permits the remaining seven engines to consume the surplus fuel and oxygen intended for the dead



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engine. The burning time of the seven remaining engines is increased, with little loss in over-all booster performance.

S-IV: As second stage of the C-1 vehicle, S-IV will be powered by six 15,000 lb thrust Pratt and Whitney RL-10 liquid hydrogen-liquid oxygen engines. S-IV is 18 ft in diameter and about 40 ft long and is being developed by Douglas Aircraft Co.

S-V: Third stage for later C-1 operational flights, S-V will be a modified Centaur. Now under development, this stage uses two RL-10 engines, and will be about 10 ft in diameter and 29 ft tall.

Off-the-Shelf Guidance

Initial Saturn guidance and control system is primarily an adaption of Jupiter-system components to meet Saturn requirements. One significant departure is the addition of rate gyros as sensing elements. Structural bending of the large and relatively flexible Saturn requires the use of rate gyros for stabilization.

Saturn will use all-inertial guidance, and more advanced hardware will be introduced into the system as the missions become more demanding. Heart of the final guidance scheme is a high-speed digital computer. In S-I, for example, the guidance system, including computer, will automatically give corrective signals necessary to compensate for loss of thrust if one of the eight H-1 engines fails to perform properly.

Mission Capability

The two-stage Saturn C-1 vehicle will be capable of placing a payload about 20,000 pounds in low orbit. An advanced three-stage configuration will be able to place more than 80,000 lb in low earth orbit, send 30,000 lb to escape velocity, or 20,000 lb to Mars or Venus.

Ultrapure Tungsten Promises Single-Crystal Parts



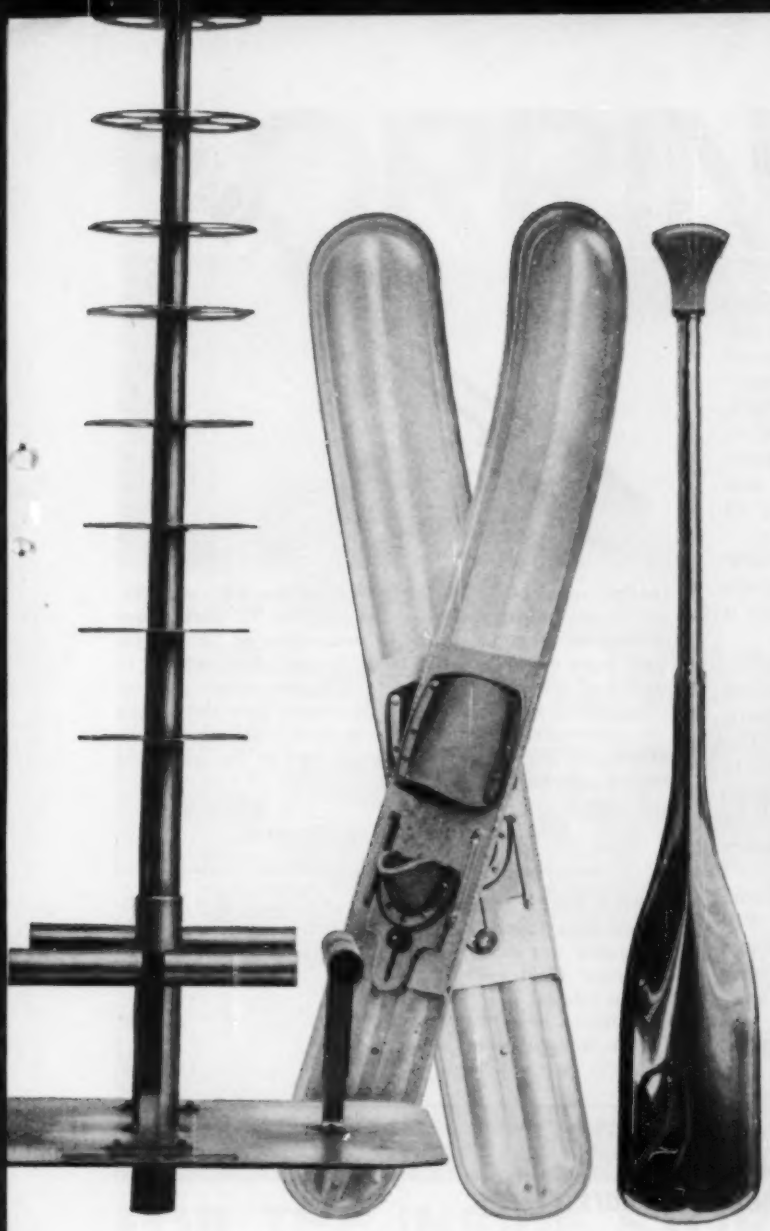
Tungsten rods 10 in. long have been produced as single crystals by Westinghouse engineers. Ultrapure crystals in other predetermined crystalline forms have also been grown. Tungsten sheets measuring 3 ft long x 0.5 in. wide x 5 mil thick are cold rolled from a single crystal, and 30-mil wire is drawn.

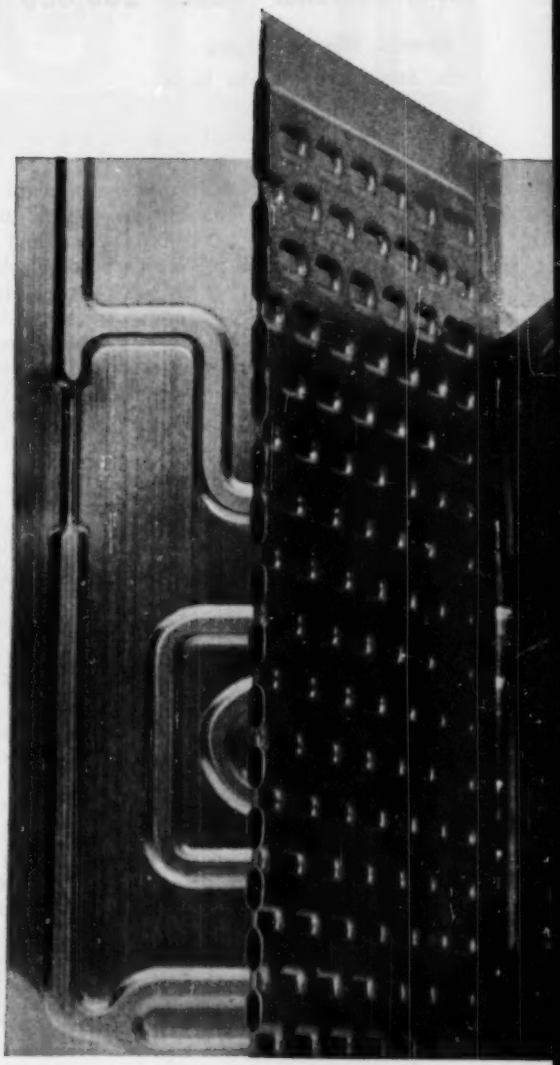
BLOOMFIELD, N. J.—By beaming electrons at special ingots, engineers at the Lamp Div., Westinghouse Electric Corp., have developed the first practical method of producing large tungsten crystals. Single crystals have been grown to 0.22 in. diam by 10 in. long with a purity of 99.9975 per cent. They can be fabricated, cold rolled into sheets, or drawn to form wire.

Tungsten is usually considered a hard, brittle metal, but Westinghouse engineers have proven that its ductility depends on purity. The ultrapure crystals retain high ductility even at temperatures as low as −330 F, and this property is expected to create new uses for the material.

The crystals are particularly valuable in studies of the fundamental properties of high-temperature metals. Tungsten, having the highest melting point and being one of the strongest of all the metals, is a promising material for applications such as rocket motors. Although much remains to be discovered about its behavior, the availability of superior tungsten crystals will open the door for advanced research in this area.

Zone-melting equipment that uses the electron-beam heating principle produces the large crystals. However, in order to attain ultrapure crystals, it was necessary to develop a process for making special high-purity tungsten ingots. The ingots are the starting material from which single crystals are grown.





What's next?

Although Roll-Bond is still largely utilized in the heat exchanger field, creative engineers are gradually discovering that the Roll-Bond principle is ideal for many processes—especially where strength and lightness are vital factors. Now, Roll-Bond uses range from refrigerators to radar antennae, from water skis to boat paddles. What's next? We're never sure. Maybe you're the designer that will see the solution to one of your company's problems in Roll-Bond—where a product can be made better for less money—or dream up an entirely new creation. As you know, any continuous tubing pattern you can draw on paper can be made into a homogeneous sheet of aluminum or copper Roll-Bond. Intriguing?

Olin
METALS DIVISION

For information, write Sales Manager, Roll-Bond Products, Olin Mathieson Chemical Corporation, East Alton, Ill.

Circle 209 on Page 19

Super Fastener Takes 300,000 PSI

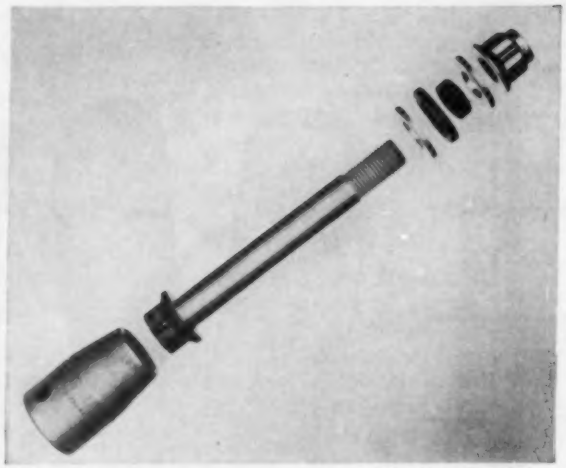
Exceeds Titanium Bolts In Strength-to-Weight Ratio

JENKINTOWN, PA.—Believed to be the first off-the-shelf fasteners with a tensile-strength rating of 300,000 psi, tension and shear bolts developed by Standard Pressed Steel Co. surpass even titanium in strength-to-density ratio (1,100,000 in. vs 1,000,000). According to SPS, various materials have previously been developed in the 300,000-psi range, but all are considerably weakened by fabrication. The new bolts, headed and threaded, retain their full strength potential under all conditions of shock and vibration loading.

Made from a new vacuum-melted alloy (Vascojet-M-A, developed by Vanadium-Alloys Steel Co.), the fasteners also offer a fatigue-strength increase that is comparable to the increased tensile strength.

A fastening system rather than a bolt, the 300,000-psi development includes mating locknuts, socket wrenches, and, for use in preloading tension bolts, preload-indicating and load-bearing washers. The allied components are essential, according to SPS, to insure that the bolts are initially tightened down to their full design strength. Recommended preload for the tension bolt is 80 per cent of yield strength—approximately 210,000 psi.

Both tension and shear bolts are being produced in a wide range of sizes—tension bolts from #10 through 7/8-in. diam; shear bolts from #10 through 5/8 in. Complete fastening systems have been developed for all versions. Tension bolts and mating locknuts are the 12-point external wrenching type, and shear bolts are being made in both 100-degree flush-head and 12-point protruding-head configurations. Upper temperature limit is presently 550 F, but a 900-F series will soon be available.



Tension superbolt, basic component in the SPS 300,000-psi fastening system, was developed for the Department of Defense. According to DOD, availability of 300,000-psi steel parts makes possible 10 to 20 per cent reduction in weight of aircraft landing gear. Complete system includes (from left to right) socket wrench, tension bolt (shear bolts are also available), four-piece preload-indicating washer assembly that becomes an integral part of the joint, and mating locknut.

Minimum Mechanical Properties

Ultimate Tensile Strength (psi)	300,000
Double Shear Strength (psi)	180,000
Elongation (per cent)	7.0
Endurance Limit (psi)	120,000*
Fatigue Life at 155,000-psi minor area (cycles)	65,000*
Tensile Strength/Density Ratio (psi/lb per cu in.)	1,100,000

*Typical or average value, rather than minimum

Fuel Cells Likely To Find Work Within Five Years

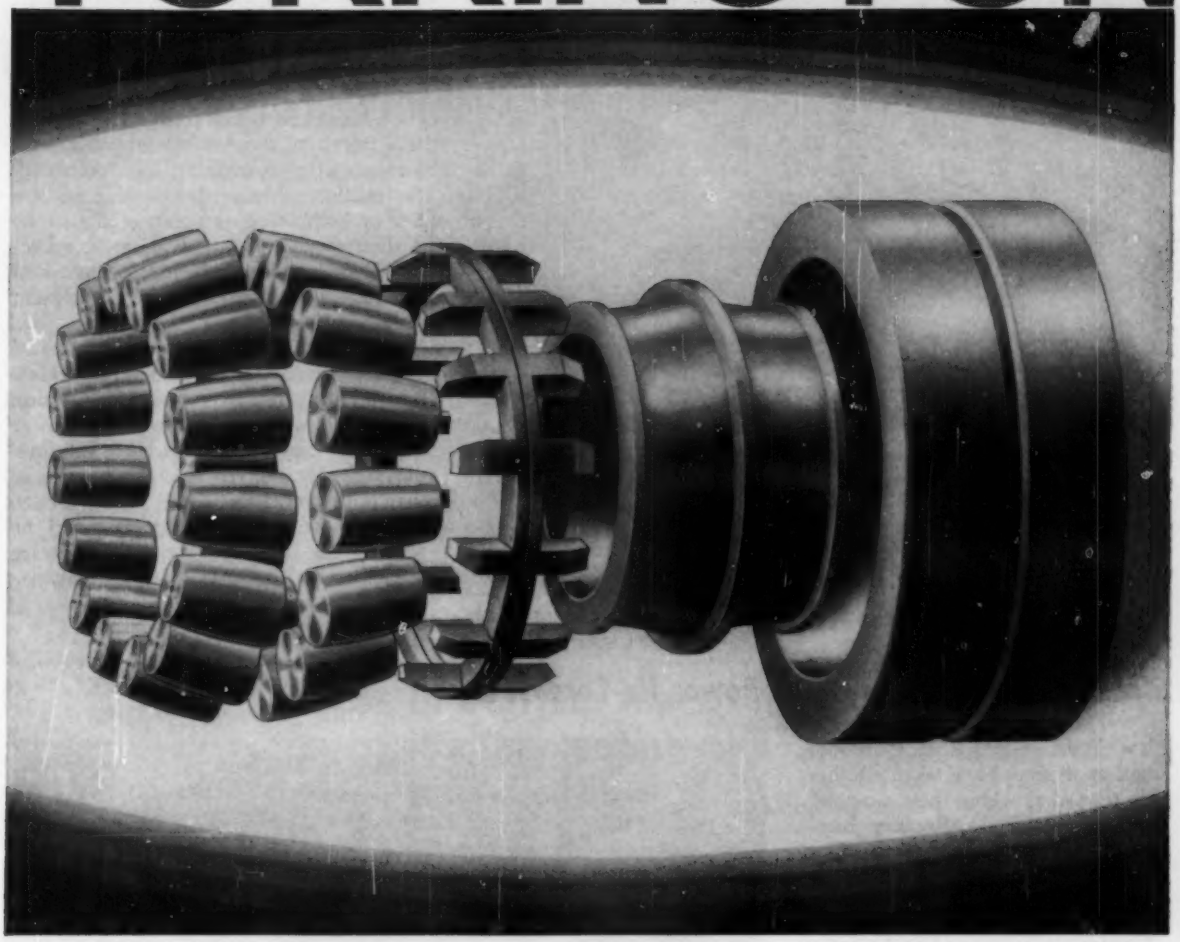
DETROIT—If the current research pace is maintained, fuel cells will probably be used as power sources in important special applications within the next five years. In fact, it is entirely possible that central power stations will eventually give way to individual cells in every home. These are the opinions of James D. Flynn, Cincinnati Gas & Electric Co., who spoke at a recent AIEE meeting.

Fuel cells, he continued, may be the inexpensive, compact successors to powerplants ranging in size from small internal combustion engines to power-generating stations. Initially, the cells will be restricted to applications where efficiency, silence, freedom from fumes, and simplicity of design and operation are important requirements. But as the technology advances, they may be used in off-peak generator facilities to produce storable hydrogen and oxygen for other cells. These could supply low voltage for such electrochemical processes as plating, water purification, galvanizing, electrolytic cleaning and electrolytic refining of metals.

The most discussed applications for fuel cells are as suppliers of electricity in places too remote for power lines or gas mains, and as emergency units in hospitals, small factories, motels, and farms.

The advantages of fuel cells give them an inside track as future powerplants: Silent operation; lack of moving parts, convenience in scaling power systems up or down; few maintenance and reliability problems; ease of tapping for supplying a variety of loads; relatively high energy per unit weight; and high specific power output particularly in the range of small-size devices. However, there are problems that remain to be solved: The tendency for efficiency to be highest at light load and to drop off with increasing load; voltage drop with increased current output; present nonexistence of materials for electrodes and electrolytes that are resistant to high-temperature corrosion, highly conductive, and low in cost. In addition, production of direct current for a technology that uses alternating current almost exclusively will require an inexpensive method of changing dc into ac.

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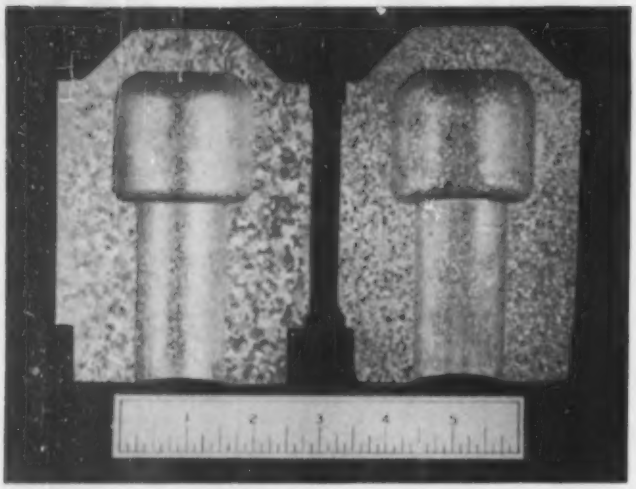
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Circle 210 on Page 19

Beryllium-Copper Castings Get a Finer Grain



Component sand cast from "ordinary" beryllium-copper alloy (left) appears coarse when compared to a part made from Berylco's new alloy. The improved grain structure is due to a grain-refining technique that will make possible lots of new uses for beryllium-copper in the sand, pressure, and investment-casting industries, according to company spokesmen.

READING, PA.—A new grain-refining technique developed by the Beryllium Corp. greatly improves beryllium-copper casting alloys. Already used in the manufacture of some Berylco alloys, the technique makes it possible to cast parts of finer grain size and higher quality.

Beryllium-copper parts cast from the fine-grain alloys have improved mechanical properties and better surfaces after machining and polishing. They also exhibit a higher degree of grain-size uniformity in both thick and thin sections. In addition, the new cast parts provide greater freedom from distortion during heat treatment and reduce the possibility of cracking during solution heat treating and aging.

Grain-size control has always been a major objective of most foundries, but has usually been difficult to attain. Extensive laboratory testing indicates that the new alloy removes this barrier to higher quality castings. Melts using the fine-grain alloys do not require special additives or special handling procedure.

Beryllium-copper casting alloys that will be available with the new fine grain property are 20CR, 165CR, 245CR, and 275CR alloys.

Stacked-Button Battery Will Power No-Cord Tools

NEW YORK — Portable tools and small appliances have taken another step toward shucking their a-c power cords completely. Yardney Electric Corp. is starting pilot production of the first hermetically sealed, rechargeable, silver-cadmium button cells. They have 75 per cent higher capacity, 60 per cent greater cycle life than similar cells of the same size, says Yardney.

Slightly larger in diameter than a half-dollar, the cells can be stacked to form D-size batteries. According to Yardney, many manufacturers are already considering the button batteries as power sources for portable machine tools, television sets, tape recorders, electric shavers, dictating machines, and movie cameras.

Life tests, conducted in a vacuum, have already surpassed 3500 charge-discharge cycles on some batteries. During each 100-min cycle, the cells are discharged 50 per cent. The buttons have demonstrated excellent capacity retention—even toward the end of their life, they operate at up to 90 per cent of rated capacity. After six months on the shelf, the new cells retain 85 per cent of their original capacity.



Silver-cadmium buttons that can be recharged thousands of times are going into pilot production at Yardney Electric Corp. Cells will be stacked into the ¼ amp-hr model pictured; ½, 1, 2, 4, and 6 amp-hr versions will also be built for customer evaluation (in D-size battery packages). They can be used over a wide temperature range and mounted in any position without leaking.

The voltage-discharge curve is nearly flat, and internal resistance is low enough to permit high peak discharges when necessary. Open circuit voltage is 1.4 v; nominal voltage under load drops to 1.1 v.

The company plans to produce stacked-button batteries in sizes ranging from ¼ to 6 amp-hr ratings.

NSPE Opens Door To Nonregistered Members

New Suggested Grade Would Carry Most Privileges

WASHINGTON—National Society of Professional Engineers is considering a proposal to broaden its membership. Approved by NSPE's Board of Directors, the proposal now goes to society members for a vote. If it passes, it will provide representation for certain engineers now not registered.

The proposed changes in NSPE constitution and bylaws would create three classes of membership: Professional - engineer member; member; and junior member. Nonregistered engineers could join the member group, provided that, as of date of approval, they belong to an approved national engineering society in a grade to which only PEs will be admitted in the future. They would have all the rights and privileges of professional-engineer members except that of holding office in the national society.

The proposal is backed by the Intersociety Relations Committee of NSPE. The Board also took two other actions:

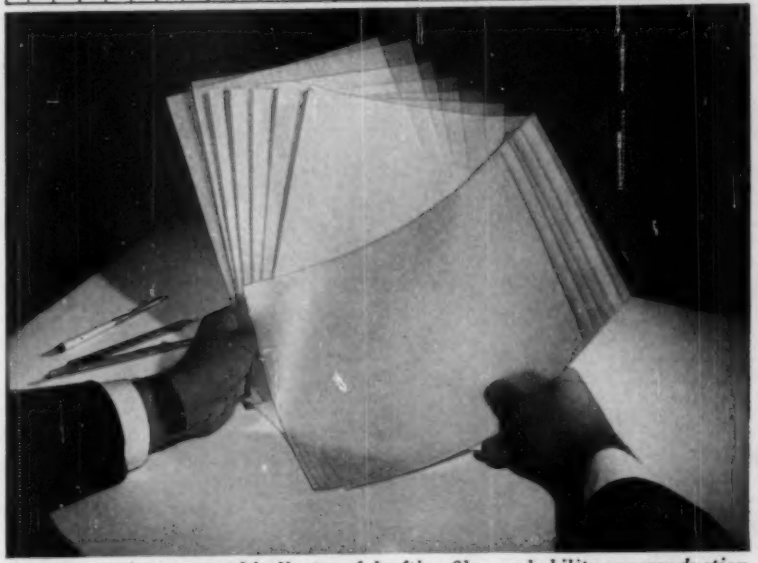
- It approved a unified statement of principle by AIEE, ASME, and NSPE concerning the functional-unity concept of the engineering profession.
- It authorized the committee to continue joint activities with other engineering groups with the aim of improving the organization of the profession.

According to Garvin H. Dyer, chairman of the Intersociety Relations Committee: "The real purpose of the whole functional concept is to get our profession unified . . . the entire profession is watching what we do about unity."

Clark Builds Servo-Tow

Name of the manufacturer was inadvertently dropped from the Design in Action feature, "Kingpin Steering with an Added Twist," on pages 182 and 183 of the October 12 issue. The fork truck described, called Ranger, is built by Clark Equipment Co., Battle Creek, Michigan. The stabilizing system for towing is called Servo-Tow. Patent has been applied for.

DRAFTING TRENDS



Appearance is not a good indicator of drafting film workability or reproduction quality—see test offer below.

In drafting films, it's the coating that counts

Film Similarities

All drafting films share one common characteristic—*every* major brand employs a polyester base. This polyester material may vary somewhat in grade (from clear to milky) or in gauge (from .002 to .007). However, its properties remain so nearly identical that no appreciable difference in print-back speed can be noted by exposing diazo material through the uncoated film. Accordingly, all polyester films have these unique features: dimensional stability, transparency, flexibility, moisture-resistance and tear strength.

Coating Differences

These advantages mean nothing to the engineer, draftsman or architect until a surface receptive to pencil and ink is put on the film. POST applies three distinct micro-coatings to its polyester film, baking these elements and the film at such high temperatures that they are literally fused. This process also "preshrinks" the material, endowing Polytex with slightly greater dimensional stability.

More Drafting Latitude

The net result of the exclusive POST *coating process is the most durable drafting film surface available*—a surface on which, if circumstances demand, you can use the hardest grade of pencil without destroying the coating. Some pencils work better than others, of course. Plastic-based pencils are best of all when permanency or washability are considered.

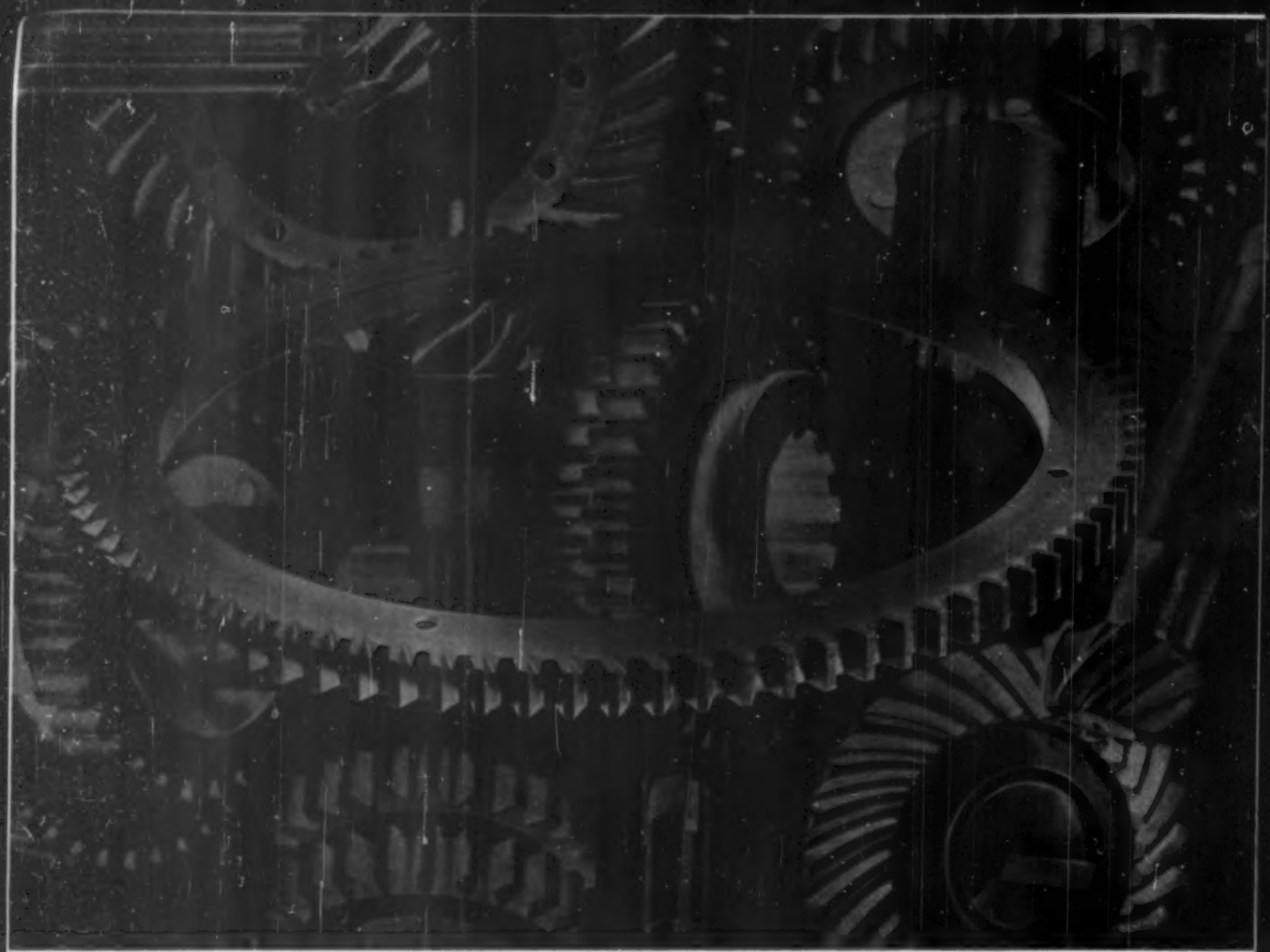
Test Offer

To convince you, regardless of previous or present drafting film experience, that POST Polytex offers a superior coating with outstanding erasibility, pencil and ink adhesion, a free Polytex test kit is yours without obligation. We'll mail an 8½ x 11 drafting film sample, plus a vinyl eraser and drafting pencil assortment, packed in a POST Pocket Protector. Write for it on your letterhead today. *Frederick Post Company, 3652 N. Avondale Avenue, Chicago 18, Ill.*

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- Design data on advertised products
- Extra copies of editorial articles

HELPFUL LITERATURE

Descriptions of items start on Page 230. Starred items are from Oct. 26 issue.

Electrical, Electronic

606 Rotary Electrical Equipment. 4 pp. Siemon Mfg. Co.

610 Integral-Horsepower Motors. 12 pp. Kohler Co.

614 High-Temperature Wires. 58 pp. Hitemp Wires Co., Div., Simplex Wire & Cable Co.

616 Foot Switches. 4 pp. General Electric Co.

620 Electronic Components. 6 pp. National Tel-Tronics Corp.

624 Multipoint Gages. 4 pp. Republic Flow Meters Co.

630 Optical Terminology. 1 p. Servo Corp. of America.

631 Impulse Transmitters. 4 pp. Landis & Gyr Inc.

634 Synchronous Motors. 4 pp. Superior Electric Co.

635 Power Control Units. 8 pp. Magnetics Inc.

640 Cooling, Retention Devices. 8 pp. Industrial Div., Birtcher Corp.

642 Tiny Switch. 2 pp. RBM Controls Div., Essex Wire Corp.

643 Capacitors and Resistors. 56 pp. Aerovox Corp.

647 Electronic Cabinet. 6 pp. Dahlstrom Mfg. Corp.

648 Zener Diodes. 4 pp. Fansteel Metallurgical Corp.

649 Push-Pull Cable. 4 pp. Push Pull Cable Div., Morse Instrument Co.

650 Timing Instruments. 16 pp. Heuer Timer Corp.

651 Miniature Delay Lines. 4 pp. Nytronics Inc.

719 Transfer Switches, Timers.* Automatic transfer switches, magnetic contactors, controls, timers. Bulletin A-17, 4 pp. Zenith Electric Co.

720 Electrical Components.* Covers four major electrical and electronic component types. 12 pp. Wabash Magnetics Inc.

721 Aluminum Boxes and Covers.* For packaging electronic components, instruments. Catalog 860, 8 pp. Zero Mfg. Co.

722 Relays, Timer Products.* Types, uses, dimensions, specifications, and enclosures. 64 pp. Telex/Aemco, Div., Telex Inc.

723 Synchros, Rotary Components.* Synchro shafts, conventions, resolvers, linear transformers, servo motors. 40 pp. Clifton Precision Products Co.

724 Electro-Optical Component.* Applications and operation of Raysistor unit. Bulletin 163-I, 12 pp. Industrial Components Div., Raytheon Co.

725 Solid-Cast Stators.* Describes Everseal encapsulation for protection of motor windings. Bulletin F-2034, 8 pp. U. S. Electrical Motors Inc.

726 Trimmer Capacitors.* Data on glass, plastic, and ceramic units. Bulletin 314-3, 16 pp. Erie Electronics Div., Erie Resistor Corp.

727 Automatic Data Logger.* Describes Data-Master unit, which collects and presents data. Bulletin D401, 4 pp. Bristol Co.

728 Plastic Wire Connectors.* For volume appliance and fixture production. Form J-240, 4 pp. Ideal Industries Inc.

729 Electronic Connectors.* Series MM-22, in 14 sizes with 5 to 104 contacts. Form MM-861, 6 pp. Electronic Sales Div., DeJur-Amsco Corp.

Hydraulic, Pneumatic

607 Valves and Cylinders. 4 pp. Rivett Lathe & Grinder Inc.

613 Glassed Pump. 4 pp. Goulds Pumps Inc.

615 Bypass Rotameters. 8 pp. Brooks Instrument Co. Inc.

617 Hydraulic Power Packages. 4 pp. Vickers Inc., Div., Sperry Rand Corp.

623 AC Pump Motors. 6 pp. Kingston-Conley Inc.

626 High-Temperature Seal. 2 pp. Pall Corp.

628 Pumps and Components. 20 pp. Oilgear Co.

629 Dry Lubricant. 2 pp. Alpha-Molykote Corp.

636 Valve Sizing. 4 pp. Jordan Valve Div., Richards Industries Inc.

641 Gate Valves. 4 pp. Lunkenheimer Co.

645 RFI Gasket. Technical Wire Products Co.

730 Solid Lubricants.* Theory and use; properties of molybdenum disulfide. Bulletin 132, 8 pp. Alpha-Molykote Corp.

731 Ball Valves.* In sizes from ⅛ to 12 in. Catalog 1200-A, 32 pp. Hills-McConna Co.

732 Hydraulic Motors.* Provide power for ac generators, fuel boost pumps, turbine starters, compressors. Bulletin A-5238, 4 pp. Aero Hydraulic, Div., Vickers Inc., Div., Sperry Rand Corp.

733 O-Ring Seals.* Explains simply how O-ring works, how seal reacts to pressure, reason for configuration. Bulletin 1-065, 6 pp. Seals East Orange Inc.

734 Air, Hydraulic Cylinders.* In ¾, 1 1/16, and 1½-in. bores Bulletin 1260, 10 pp. Bimba Mfg. Co.

735 Hydraulic Rubber Hose.* Covers R 301 and R 302 basic types of nonskive hose. 14 pp. Titeflex Inc.

736 O-Rings.* Physical properties of stock compounds listed. 4 pp. Irving B. Moore Corp.

737 Remote Valve Control.* Provides data on types of manual remote control for valves. Bulletin 618, 20 pp. Stow Mfg. Co.

Mechanical Equipment

601 High-Temperature Bearings. 3 pp. Industrial Tectonics Inc.

604 Variable-Power Drives. 8 pp. Ferguson Machine Co. Div., Universal Match Corp.

618 Cams and Camshafts. 6 pp. Eonic Inc.

625 Lubricated Bearings. 12 pp. T. B. Wood's Sons Co.

632 Light-Duty Conveyor Chains. 40 pp. Chain Belt Co.

633 Motor Bases. 8 pp. Manheim Mfg. & Belting Co.

638 Solenoid-Operated Brakes. 4 pp. Cutler-Hammer Inc.

738 Plastic Balls.* Physical characteristics, tolerances, applications. 4 pp. Ace Plastic Co.

739 Electromagnetic Disc Brake.* Series 87,000 Auto-Adjust units covered.

740 Miniature Ball Bearings.* Data on both inch and metric series units. 48 pp. New Departure Div., General Motors Corp.

741 Conveyors and Components.* Portable and adjustable units and components. Catalog MF-100A, 8 pp. Mov-Fron Mfg. Co.

742 Seamless Mylar Belts.* For precision power transmission. 4 pp. Kinelogic Corp.

743 Mechanical Differentials.* General data; 27 drawings of various units. Brochure 8101, 44 pp. Dynamic Gear Co.

Assembly Components

608 Self-Sealing Fasteners. 4 pp. A.P.M. Corp.

612 Instrument Counters. 16 pp. Durant Mfg. Co.

621 Standard Lock Bolts. 8 pp. Engineered Fasteners Div., Townsend Co.

744 One-Piece Fasteners.* Speed Nut units; gives applications, engineering data. Bulletin 359, 32 pp. Tinnerman Products Inc.

745 Constant-Force Springs.* Negator extension units covered; includes design tables. Data Book Section 6, 10 pp. Hunter Spring Co., Div., American Machine & Metals Inc.

Manufacturing Processes, Parts

603 High-Alloy Castings. 20 pp. Duraloy Co.

619 Welding Symbols Chart. Lenco Inc.

Materials

609 Fluorosilicone Data. 8 pp. Dow Corning Corp.

611 Nylon Shapes. 8 pp. Cadillac Plastic & Chemical Co.

627 Reinforced Plastic. 2 pp. Taylor Fibre Co.

644 Acrylic Molding Powder. 4 pp. Rohm & Haas Co.

746 Polycarbonate Resin.* Lexan resin for electrical and electronic components. Bulletin CDC-397, 6 pp. Chemical Materials Dept., General Electric Co.

747 Synthetic Fiber Felts.* Of polypropylene, Teflon, Dacron, Dynel, rayon viscose, Orlon, nylon. Bulletin 4-61, 8 pp. American Felt Co.

748 Metal Structural Material.* Lindsay material with high strength-to-weight ratio. 60 pp. International Steel Co.

749 Hollow Aluminum Stock.* Details cost savings, gives specifications, ratings. "The Hole Story," 12 pp. Aluminum Co. of America.

Engineering Dept. Equipment

602 Portable Tensile Testers. 4 pp. Hunter Spring Co., Div., American Machine & Metals Inc.

605 Weldable Strain Gages. 2 pp. Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp.

622 Data-Acquisition System. 16 pp. Consolidated Systems Corp.

637 Data-Recording System. 4 pp. Westrex Co., Div., Litton Systems Inc.

639 Humidity Meter. 2 pp. Telostat Corp.

646 Tape Recorder-Reproducer. 4 pp. Ampex Corp.

NEW PARTS, MATERIALS, ENGINEERING EQUIPMENT

Descriptions start on Page 246.

Electrical, Electronic

682 Miniature lamp prevents complete failure of signaling function. Chicago Miniature Lamp Works.

655 Multiple switch is 6 or 12-station unit. Switchcraft Inc.

656 Small relay has speed of less than 0.8 millisec. New Products Inc.

660 Printed-circuit board requires no etching or other preparation. Corning Glass Works.

661 Tantalum capacitors are available in working voltages of 6 to 125 v dc. Tansitor Electronics Inc.

662 Multiple assembly socket has prewired common side. Sockets Div., Allegri-Tech Inc.

664 Unidirectional motor offers ratings to 0.005 hp. Motors & Components Div., Barber-Colman Co.

668 Printed circuits are miniature, multilayered units. Photocircuits Corp.

671 Pressure switch for pressures from 0.5 to 3000 psig. Control Components Div., International Resistance Co.

673 Insulated stand-off has self-locking feature for attaching screw. Spyrafio Inc.

677 Limited-rotation motors in Size 15 and Size 23 units. Power-Tronic Systems Inc.

679 DC motor for use in computer drives. Eicor Div., Indiana General Corp.

682 Ceramic-disc capacitors for operating temperatures from −30 to +85 C. Erie Resistor Corp.

684 DC torque motors have peak torques from 20 to 350 oz-in. Giannini Controls Corp.

687 Feed-through capacitors have ratings from 4.7 to 1.0 *mf*. Rectifier-Capacitor Div., Fansteel Metallurgical Corp.

690 Heat dissipator, retainer for application with TO-18 transistors. IERC Div., International Electronic Research Corp.

691 Miniature plug exceeds all requirements of MIL-C-25955. Cannon Electric Co.

694 Synchronous motor has speed of 8000 rpm. Kearfott Div., General Precision Inc.

695 Silicon-controlled rectifiers in 10 and 16-amp units have fast switching speeds. International Rectifier Corp.

698 Manual starter for two-speed, fractional-horsepower motors. Cutler-Hammer.

699 Acrylic sleeving retains good flexibility on heat aging. L. Frank Markel & Sons.

700 Impulse counter is miniaturized, dial-type unit. Automatic Timing & Controls Inc.

702 Gang switch assemblies in six basic types. Poncar Inc.

704 Sequence timer is battery-powered, accurate to ±10 sec per day. Geodyne Corp.

705 Component clamps for subminiature, T-3 envelopes. Birtcher Corp., Industrial Div.

708 Steady-state switch handles up to 35-amp inrush. Micro Switch Div., Minneapolis-Honeywell Regulator Co.

710 Miniature rheostat has high power-handling capability. Ohmite Mfg. Co.

Hydraulic, Pneumatic

659 Vaneaxial blower has maximum current of 1.15 amp at 53 cfm free-air delivery. Globe Industries Inc.

665 Miniature cylinder for up to 250 psi air and 2000 psi hydraulic. Clippard Instrument Laboratory Inc.

669 Right-angle valves for operating pressures to 5000 psi. Manatrol Corp.

670 Ball valves for vacuum processing systems. F. J. Stokes Corp.

675 Teflon-coated seals reduce breakout and running friction. Seals East Orange Inc.

680 Tubeaxial fan is 1¼ in. thick, has 3 1/16-in. diam. Eastern Div., IMC Magnetics Corp.

683 Remote-control operator for use with all makes of quarter-turn ball valves. Ju-No Supply Corp.

685 Expansion joints have one-piece construction. Crane Packing Co.

689 Long-stroke diaphragms have low permeability characteristics. Diaphragm Industries Inc.

692 Rotary seal operates in temperatures from −300 to +165 F. Mechtronics Corp.

696 Motor-driven pump furnishes flows from 1.5 to 2.5 gpm at 225 psi. Lear-Romec Div., Lear Inc.

703 Shutoff valve delivers fluids under pressures to 6000 psig. Koehler Aircraft Products Co.

706 Teflon-slotted O-rings for use with nonflammable hydraulic fluids. Gorlock Inc.

707 Centrifugal pumps are leakproof, single-suction units. Buffalo Pumps Div., Buffalo Forge Co.

709 Hydraulic valve incorporates light to indicate application of power. Racine Hydraulics & Machinery Inc.

711 Slide valve for pressures to 1400 psi weighs 13 oz. Herion Inc.

Mechanical Equipment

657 Right-angle gear drive has high horsepower and torque capacity. Tol-O-Matic Inc.

663 O-ring bearings in flanged and unflanged types need no lubrication. Microtech Div., Federal-Mogul-Bower Bearings Inc.

667 Miniature slip clutch is adjustable from 0 to 50 oz-in. torque. Northfield Precision Instrument Corp.

674 Roller chain is self-lubricating. Chain Belt Co.

676 Adjustable-speed transmissions in sizes from 1/6 to 1½ hp. Graham Transmissions Inc.

681 Speed reducers in 22 standard horizontal units. Falk Corp.

688 Precision racks of Type 416 stainless steel in eight diametral pitches. PIC Design Corp.

701 Torque converter for 3 to 7½-hp gasoline engines. Salsbury Corp.

Assembly Components

653 Square-pointed fastener is thread-forming. National Lock Co.

658 Circulating-ball slide supports weights in 1000-lb range. Chassis-Trak Inc.

666 Liquid-spring shocks are double acting. Taylor Devices Inc.

Materials

654 Polyurethane coatings protect surfaces exposed to corrosion or hard use. Hughson Chemical Co., Div., Lord Mfg. Co.

672 Silicone-rubber foam cures at room temperature. Dow Corning Corp.

678 Dip-coating compounds for plastics, ceramic, metal parts. Furane Plastics Inc.

686 Laminated plastic has high flexural strength. Laminated Products Dept., General Electric Co.

693 Pure cobalt strip has good ductility and workability. Sherritt Gordon Mines Ltd.

697 Adhesive film gives bonds to 1500 psi. Girder Process Inc.

Engineering Dept. Equipment

712 Vacuum-tube voltmeter has frequency response from 10 cps to 500 kc, ± 1 db. Heath Co.

713 Transistorized oscilloscopes for medium to high-frequency range. Allen B. Du Mont Laboratories, Div., Fairchild Camera & Instrument Corp.

714 Modular power supplies operate at full ratings without heat sink to 35 C. Power Sources Inc.

716 Direct-recording oscillograph has 24 channels in 7-in. rack height. Heiland Div., Minneapolis-Honeywell Regulator Co.

717 Filing cabinet accommodates material measuring 17 x 22 in. Clarkson Co.

718 Compass, beam attachment for use with Rapidograph drawing-point sections. Koh-I-Noor Inc.

Circle the item number for information on products advertised or described, literature offered, and copies of editorial articles.

EDITORIAL ARTICLES

Single copies of the following articles are available as long as the supply lasts. Starred items are from previous issues. See Page 309 for other available reprints. Editorial content of MACHINE DESIGN is indexed in the Applied Science Technology Index and the Engineering Index, both available in libraries. Microfilm copies are available from University Microfilms, 313 N. First St., Ann Arbor, Mich.

23-1 Fine-Wire Splices. New semiautomatic machine crimps 350 sound splices per hour. (2 pp.)

23-2 Freedom for Engineers. Engineers' feelings about on-the-job freedom; how management can relax controls yet not give up over-all program direction. (5 pp.)

23-3 Double Patenting. What happens when two patents are issued on the same invention. (4 pp.)

23-4 Audible Signals. Relating basic properties of sound to the selection of sound-producing devices. (9 pp.)

23-5 Minimum-Weight Castings. Seven steps in designing castings for minimum weight and cost. (2 pp.)

23-6 Thermal Stresses—Part 1. How to determine whether a material is suitable for a thermal-stress application. (6 pp.)

23-7 Flat Springs. Eight ways of providing uniform or varying spring rate. (1 p.)

23-8 Water-Glycol Hydraulic Fluids. Properties and characteristics of a widely-used fire-resistant fluid. (4 pp.)

23-9 Shaft Materials. Choosing the right material for shafts with integral bearing races. (4 pp.)

23-10 Powder-Metal Gears. Proposed tooth profile, based on principles used in the design of highly stressed gears, to provide greater load-carrying capacity. (3 pp.)

23-11 Beams with Nonuniform Stiffness. Two numerical methods for calculating deflection of cantilever beams with varying stiffness. (5 pp.)

23-12 Electroluminescent Lamps—Abstract. Lighting with "EL" lamps for compact numerical displays. (3 pp.)

22-4 Compression-Spring Design.* Design methods, procedures, materials, allowable-stress data. (11 pp.)

22-7 Keeping Bolted Joints Tight.* Avoiding decoupling of vibrating joints held together by threaded fasteners. (4 pp.)

21-5 Servovalves for Force Control.* Using servovalves for accurate control of force in hydraulic systems. (6 pp.)

21-10 Critical Speed of Shafts.* Nomogram for quickly finding critical speed of shafts. (3 pp.)

20-3 Gasket Loads.* Four techniques for evaluating flange pressure factors to improve flanged-joint design. (7 pp.)

20-9 Pin-Joint Design.* Nomograph design procedure for matching joint proportions to operating requirements. (4 pp.)

19-3 Statistical Dimensioning Program.* Setting up a program to improve the way assemblies function, while allowing all possible dimensional tolerance. (6 pp.)

19-11 Quadratics-Cubics-Quartics.* Three methods, based on nomograms, to get quick, direct answers; procedure for refining roots to any degree of accuracy. (8 pp.)

18-2 Engineering and Research Reports.* Developing effective technical reports; seven most important kinds. (6 pp.)

18-3 Flame-Sprayed Coatings.* Four methods of flame-spraying protective coatings; guide to material selection, design of flame-sprayed parts. (11 pp.)

17-4 Critical Speeds of Coupled Machines.* Method for determining the critical speed, or natural lateral frequency, of an entire system. (7 pp.)

17-7 Radii of Gyration.* Nomograms for determining K^2 where multiple dimensions occur. (5 pp.)

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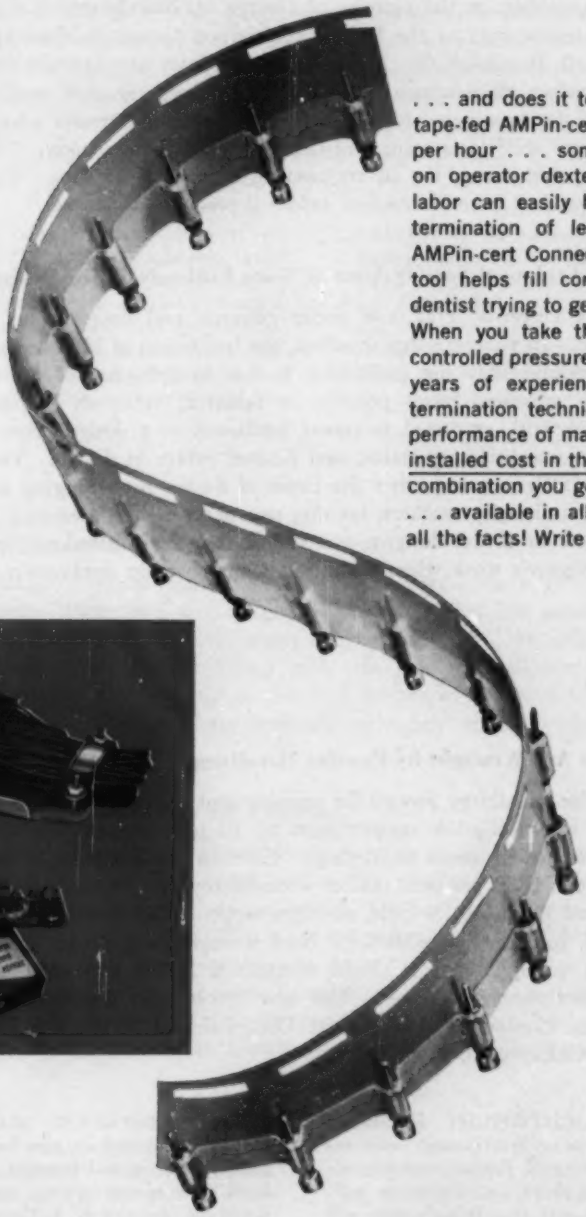
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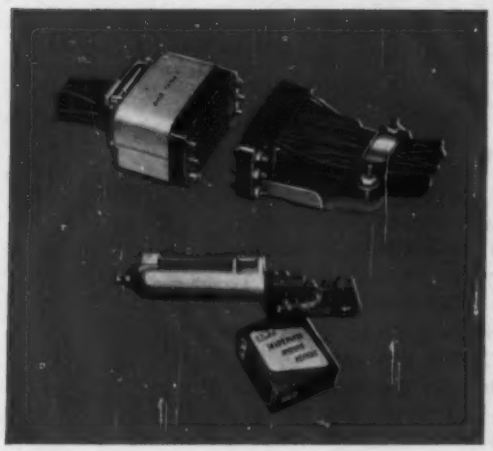
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trends

engineering/personnel

Obsolescence and Technology Plague the Boss

Engineering management is faced with new responsibilities in the area of profit-making, in the opinion of George M. Muschamp, vice president of engineering of the Industrial Products Group of Minneapolis-Honeywell Regulator Co. These responsibilities are brought on by rapid product obsolescence and the need to keep up with new technological developments. Mr. Muschamp believes that greater selectivity of products and closer control of their costs will be necessary. "Nothing is so devastating for an engineering manager," he says, "than to have a product become obsolete before it reaches the market."

British Technical Society Aims at More Enthusiasm for Design

British engineering graduates prefer research and development work to design. In studying this situation, the Institution of Mechanical Engineers found that the preference is due to influence of university teachers; advanced work possible in research; relatively elementary nature of work entrusted to recent graduates in a design office; and low pay, unsatisfactory status, and limited future in design. The Institution feels it can further the cause of design by arranging discussions for university teachers, inviting papers on design, awarding prizes for papers or actual designs, and considering the professional quality of a designer's work when reviewing a membership application.

products/processes

Savings Are Wrought by Powder Metallurgy



A powder-metallurgy process for pressing and sintering copper cuts the cost of electrical-grade copper parts by 10 per cent, on the average, compared to extrusions or forgings. Electrical conductivity of the sintered parts is 93 per cent that of wrought copper. Hardness is 80 R_F, compared to 87 R_F for hard wrought copper. Tensile strength is 39,000 psi, compared to 45,000 for hard wrought copper and 33,000 psi for soft wrought copper. Yield strength is 36,000 psi—4000 psi less than hard wrought copper. The new process was developed by the Electrical Contacts and Specialties Div., Fansteel Metallurgical Corp., North Chicago, Ill.

HIGH-SPEED, LIGHTWEIGHT DIESELS—the result of a "major breakthrough"—are expected soon by Victor G. Raviolo, executive director of the Ford Motor Co. engineering staff. Mr. Raviolo said that this breakthrough will make diesel engines suitable for taxi cabs, delivery trucks, and farm trucks. Their use in private passenger cars will depend on fuel prices and taxes. Mr. Raviolo also mentioned that the gas turbine may be important in future transportation. Ford is "well along" with a supercharged model with fuel economy of a diesel.

PURE, NONPOROUS 24-KARAT GOLD PLATE is deposited on parts for semiconductors, printed circuitry, and instruments by the Aurall Gold electroplating process, developed by Lea-Ronal Inc., Jamaica, N. Y. Deposits made by the new process are lustrous, show excellent ductility, and are markedly free from porosity—copper and copper-alloy parts coated with 50 to 100 millionths of Aurall Gold withstand boiling concentrated nitric acid. Silver or silver-plated parts with the new coating are not affected by standard hydrogen-sulfide tests.

Nonmagnetic Nitinols Are All-Purpose Alloys

Nitinols—nickel-titanium alloys that are heavy on nickel—have some very unusual properties, according to the U. S. Naval Ordnance Laboratory, White Oak, Md. Nonmagnetic, corrosion resistant, and strong, they are toughest at low temperatures, yet they can be used at up to 1200 F. They harden to 62 Rockwell C—almost the hardness of tool steel—and have very high mechanical vibration capacities. Low specific gravity (6.45) permits the alloys to offer strength without adding weight to aircraft, tools, or other pieces of equipment.

MAGNESIUM ALLOYS that contain 11 per cent or more lithium are considerably lighter and more ductile than magnesium, according to Paul D. Frost, Battelle Memorial Institute. Used in missiles, they could step up weight-to-payload ratio considerably. Since the new alloys resist penetration by high-velocity particles, they could protect space craft from micrometeorites.

NEWEST of the solid-state-maser materials is neodymium in calcium tungstate. Bell Laboratories has built an optical maser from it, and the device exhibits strong infrared fluorescence and operates at room temperature with as little as five joules of input power. The emission line is in the desirable (photographic) part of the infrared spectrum—10,600 angstroms.

Collators Jump a Generation

By designing a core memory for the punched-card collator, International Business Machines Corp. claims to have upgraded the machine one whole generation. Standard equipment on the IBM 188 collator, the alphameric unit replaces relays with core storage, and vacuum tubes with transistors. Memory is therefore electronic, rather than electromechanical. The machine performs with new speed, capacity, and reliability.



Control (Numeric) on the Campus

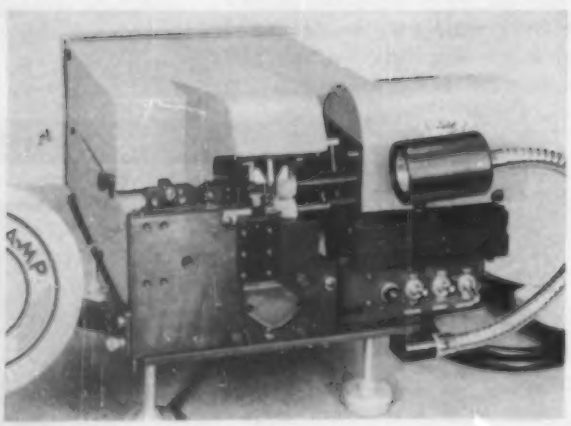
A complete tape-controlled machine-tool system is being set up at UCLA, where production and design-engineering students will soon receive training in use of the automated-factory. The last link, a special-purpose computer valued at $97,250, has been presented by General Dynamics/Electronics. Only four computers of the type are in existence; UCLA's is the prototype for the other three. Once completed, the automated system will need little maintenance, but it will turn out any part faster, cheaper, and more accurately than can be done by hand.

TWO TO 24 MILLION POUND THRUST liquid rocket engines are the goal of a new program sponsored by NASA. Aerojet-General Corp. and Rocketdyne Div. of North American Aviation will investigate new techniques of building large liquid rocket engines to find out if there is a design concept that will result in savings as well as increased reliability. Propellants involved are liquid oxygen/hydrocarbons and liquid oxygen/liquid hydrogen.

A LIGHTWEIGHT VEHICLE for reconnoitering the moon before heavier mobile equipment is landed has been designed by Space-General Corp., Glendale, Calif. It is solar-powered and controlled by stereo television. Present plans call for it to walk on three pairs of legs at 2 or 3 mph, carrying 26 lb of experimental equipment. Folded into a 40 x 40 x 12-in. package, the vehicle could be lofted onto the moon by an Atlas-Centaur-Surveyor.

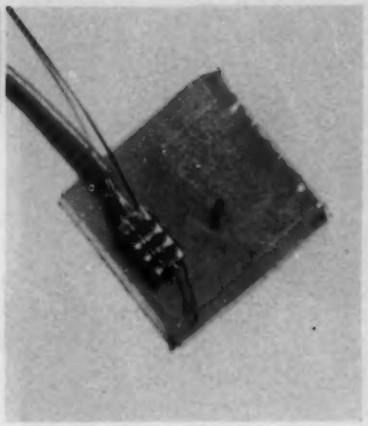


Practiced operators, says AMP, can make a finished fine-wire splice (including component handling time) in less than 7 sec when working with 38-gage wire. Rates are somewhat slower for 44-gage (0.002-in. diam) wire. The new semi-automatic splicer will join wires as fine as 48 gage (0.0012-in. diam); however, such hair-thin wire must be prestripped before being placed in the machine.



The Fine Y-R splicer employs only one splice size (packaged 3000 per tape reel) in joining 34 to 44 magnet wire (AWG) to 26 gage or finer stranded lead wire. Within the total range of the machine, repositioning of the fiber-glass insulation-stripping wheels is the only adjustment required.





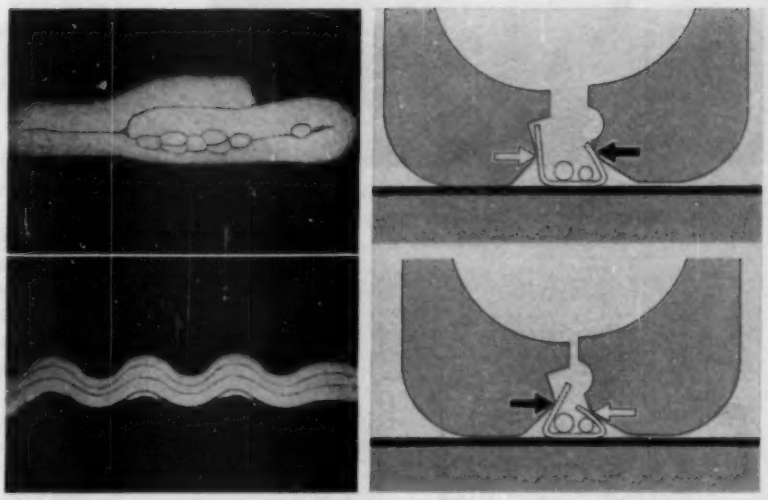
Trimmed 3/8-in. square of Mylar tape, which remains with the crimped fine-wire splice, forms an integral insulating pad. Placed tab-down against coil windings, the splice can be further insulated and protected by an outer tape wrapping.

Fine-Wire Splices in Seconds

EVERY wire, it can be observed, has two ends. While hardly remarkable, this fact can plague the electrical/electronic packaging specialist—especially when the wire falls in the fine-gage category. Components like relays, voice coils, transformers, and meter movements —often fabricated with hair-thin magnet wire—must be connected to the rest of the circuitry. A production bottleneck arises in splicing lead wires to coil-wire ends with diameters from 0.008 in. (32 AWG) down to 0.0012 in. (48 AWG) or smaller. Normal rates for making soldered connections, the usual technique, range from 30 per hour to 200 per hour. Including wire-preparation time, a rate of 150 is considered excellent for soldering a stranded lead wire to a fine-gage magnet wire.

Aiming at a market that may include two billion fine-wire connections per year, AMP Inc., Harrisburg, Pa., has devised a new solderless splicing method called Fine Y-R Splice. Key to the technique is a high-speed, semi-automatic machine that will permit a practiced operator to turn out sound splices at a 350-per-hour rate. The machine joins magnet wire of any size between 34 AWG and 44 AWG to stranded lead wire of 26 gage or finer. Up to a total of nine 0.006 in. diam or finer wire strands are accommodated in each splice.

Activated by an air cylinder and an electric motor, AMP's splice applicator incorporates fiber glass abrasive stripping wheels that remove the magnet-wire insulation, also hold tension on the wires until the splice is completed. The tin-plated copper clips, which measure 0.060 in. wide, 0.125 in. long, and 0.050 in. on a leg (uncrimped) are mounted on Mylar tape—3000 splices per throwaway tape reel.



Split-second prefolding action of splicer fingers (right)—followed by a straight squeeze between anvil and punch—locks the splice firmly, produces a multifold connection that will not relax under heat or tension. Photomicrographs (left) show fine wires firmly imbedded in the soft copper of the crimped splice, a condition that insures low resistance of the connection. Wavy form produced by the serrated punch further improves the integrity of the splice.

According to AMP, the splice is unusually stable, has exhibited no failures when subjected to severe tests. Temperature cycling, for example, between −60 C and 100 C caused no measurable drift in the resistance of test splices. Exposure to humidity, vibration, and a hydrogen-sulphide atmosphere resulted in only minor resistance deviations. Average resistance of a splice was less than 0.1 milliohms, and maximum for any sample tested was 0.19 milliohms.

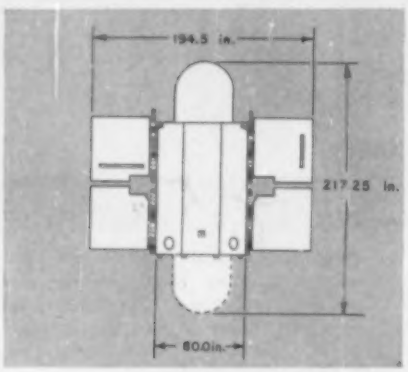
Cost of the new system, says AMP, is justified only when the volume of work is large. With large-volume production, however, savings are substantial, and the number of rejects normally associated with fine-wire soldering can be expected to fall.

Observatory in Orbit Has Better Aim Than Palomar

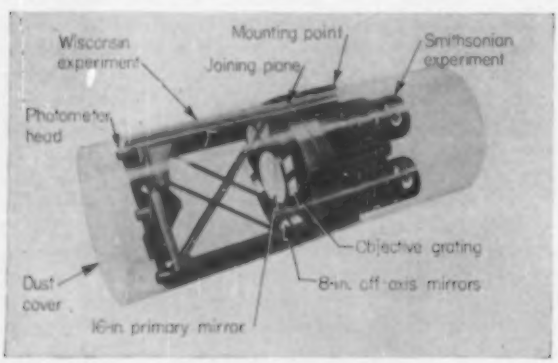
Stable Platform for OAO Is Best Yet Achieved



Largest scientific satellite now under development, NASA's Orbiting Astronomical Observatory will be a precisely stabilized cosmic laboratory . . .



. . . Central structural tube (below) has four pick up points which can support an experiment package measuring 40 in. OD by 110 in. long, and weighing as much as 800 lb.



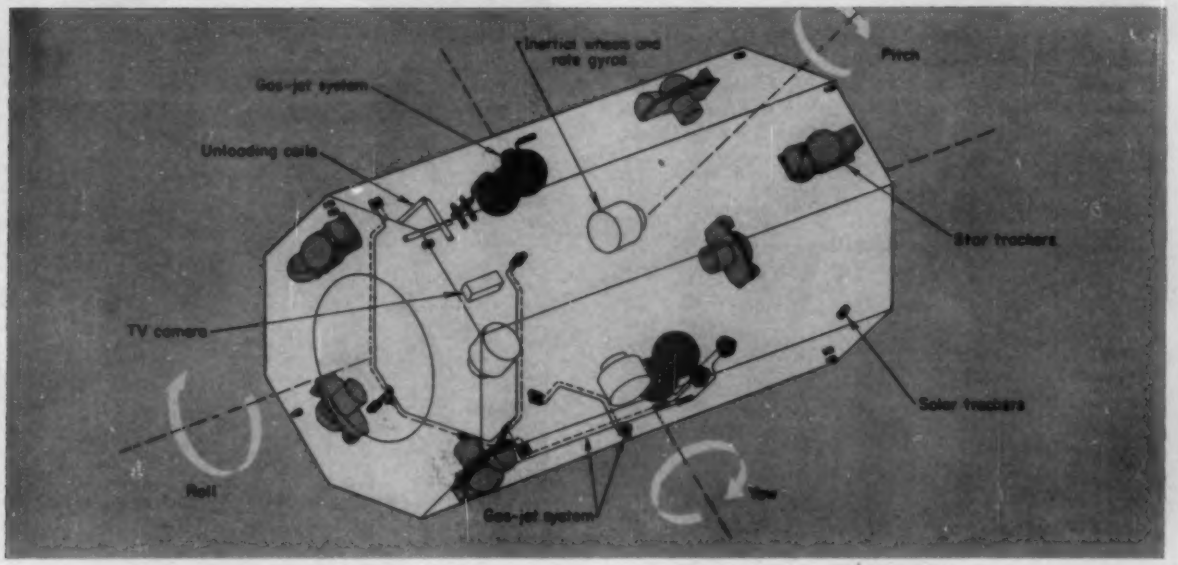
MANY basic unknowns in astronomy will be unveiled when NASA's Orbiting Astronomical Observatory is launched sometime in 1963. The largest unmanned scientific satellite now under development in the U. S., OAO will weigh 3300 lb, carry up to 1000 lb of instrumentation, including a 36-in. mirror and spectrometer. It will be placed into a 500-mile circular orbit by an Atlas-Agena B vehicle.

According to Grumman Aircraft Engineering Corp., OAO builder, the satellite's stabilization equipment will be so precise that its pointing accuracy will exceed that of any observatory on Earth. Astronomical equipment in the satellite will "lock" onto the sun, stars, or planets to an accuracy of 0.1 sec of arc. This is roughly equivalent to focusing on a basketball 500 miles away.

Actually a stable platform, OAO will be a standardized shell—containing stabilization, power, and telemetry instruments—into which one or more separate experiments can be fitted for each flight. Astronomical equipment with reflecting mirrors up to 36 in. in diameter will be mounted in a 40-in. cylindrical chamber running through its length.

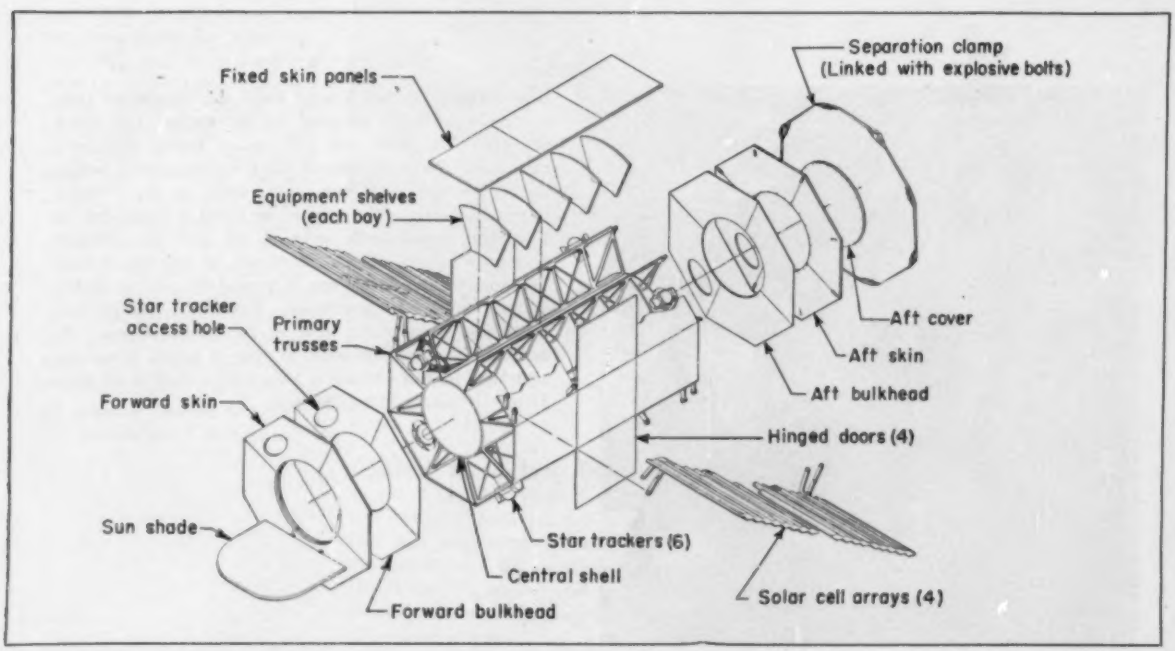
A number of experiments are already planned for OAO:

- Smithsonian Astrophysical Observatory's proposal to use several 8-in. telescopes, each coupled with a video tube, to map ultraviolet radiation over the entire sky. Hydrogen, over a thousand times more prevalent than all other elements combined in the universe, shows its presence most strongly in the ultraviolet region. Also because baby stars probably have strong ultraviolet emissions, it is hoped to learn more about how stars are born.
- NASA's proposal to use a 36-in. mirror and spectrometer to study emissions from a wide range of celestial bodies. Sounding rocket flights have indicated areas in the sky which are particularly bright with ultraviolet radiation invisible to optical and radio telescopes. This experiment is designed to further investigate these areas.
- Princeton University Observatory's proposal to use a 24-in. mirror and spectrometer to study cosmic dust by observing it against the stars. This experiment will indicate whether the elements occur in the same relative proportion everywhere in space.
- Harvard University's proposal to make spectrographic studies of solar activities to help further understanding of Sun-Earth relationships.



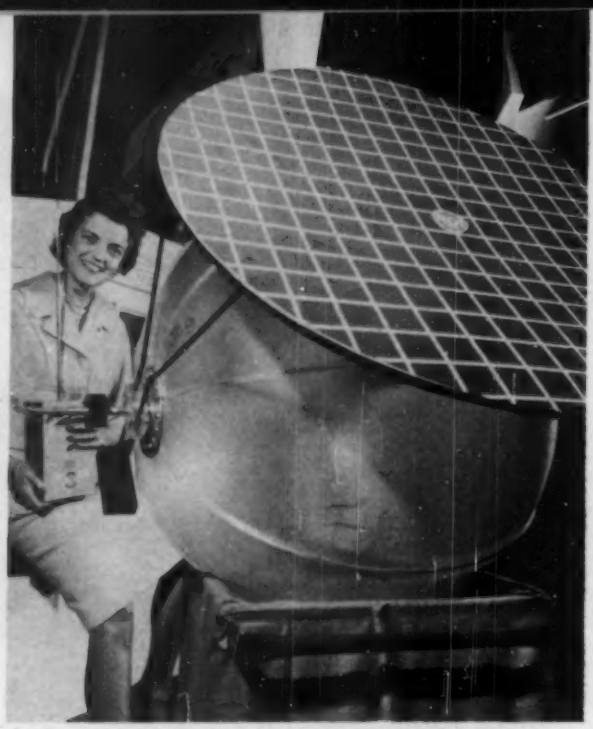
PRECISE STABILIZATION: Following separation of spacecraft and booster, rate gyros, solar trackers, and gas jets will stop initial tumbling and align OAO's optical axis with the sun-line to within ±0.25 degree. The observatory will then roll about the optical axis at approximately 0.2 deg/sec, activated by the gas jets. During this period, the star trackers will assume a predetermined pointing angle with respect to the optical axis. Because each tracker has only a 1-degree field of view, it is possible to preselect a set of star-tracker pointing angles so that there is only one roll orientation at which all trackers will simultaneously detect guide stars. When that roll angle is detected, the gas jets stop further rolling. Thereafter, coarse slewing, to point the spacecraft to any arbitrary position in space, is accomplished by use of the star trackers and by actuation of coarse inertia wheels. Fine inertia wheels, used in conjunction with an error detector, will precisely stabilize the vehicle. Television provides a back-up for determining spacecraft orientation. Accumulated angular momentum, resulting from disturbance torques, is "unloaded" by means of the gas jets or magnetic equipment.

RIGID STRUCTURE: Since maintenance of alignment in orbit is a primary consideration, the structure is designed to have extreme rigidity and minimum thermal distortions. The basic structure is aluminum; titanium is used to mount key components.



Uncluttered lines distinguish the Stuart electric car, the first vehicle of this type offered to consumers in more than 20 years. The new electric, to be marketed early in 1962, runs on conventional lead-acid batteries which can be recharged by plugging into a 110-v outlet. Its range is about 35 miles. Body shell and floor of the Stuart are fiber glass, and the interior is a washable plastic material.





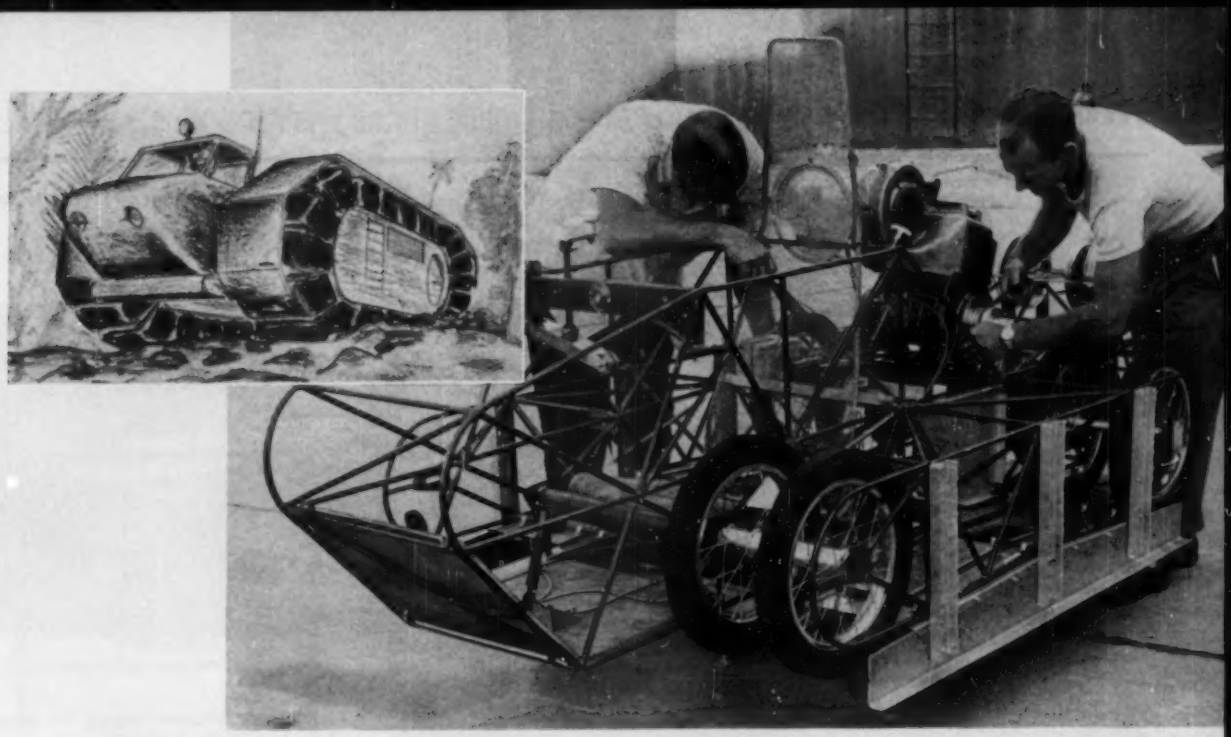
Lunar explorer may take the shape of this "moon roller," demonstrated at the recent American Rocket Society show. Inflated to the desired size after delivery to the moon and steered by television cameras and electronic sensing instruments, the roller would gather samples of the moon's surface and transmit its findings back to earth. It was developed by the Astro-Electronics Div. of Radio Corp. of America.

ENGINEERING NEWS

PICTURE REPORT

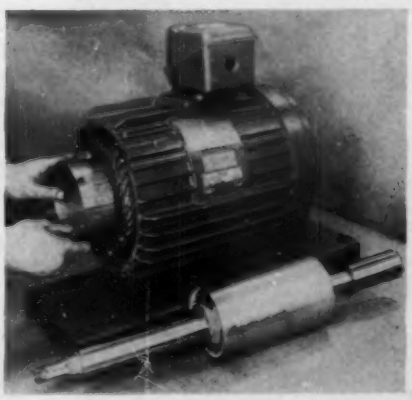


Big noises bounce around inside this reverberant tank to test components designed for jet aircraft and space vehicles. The tank and two square testing chambers, part of the Goodyear Aircraft Corp. environmental testing facility in Litchfield Park, Ariz., make up the "world's largest hi-fi set." The part to be tested is suspended on a rubber shock cord; noise is fed into the chamber through a side opening. The sound, at frequencies from 37 to more than 10,000 cps, is created by passing electric current through a zener diode. Frequency, variable during a test, is controlled from an instrument console. An analyzer permits verification of type of sound, frequency, and level in decibels, and a permanent record of all these factors is made during the test.



A go-anywhere vehicle is the goal of research that produced this half-scale test bed. Chance Vought Corp., subsidiary of Ling-Temco-Vought, is developing a cargo or personnel carrier for the Army that will travel on hard surfaces, water, snow, mud, or tundra. Resembling a tank, the PAT (plenum air track) vehicle will ride on a continuous track of rubber-impregnated cells filled with low-pressure air. Air blown on the outside of the tracks will keep them clean, and an endless manifold system will damp vibration to keep the vehicle from bounding when it travels over smooth terrain. Expected speeds are 50 mph on the highway, 30 mph on water. The PAT will be light enough to be carried by air transport or helicopter; payload is to equal its weight.

Redesign for arc welding saved $192 on this canned motor pump made by Allis-Chalmers Mfg. Co. It won a $3000 prize for G. H. Lynn, manufacturing specialist, and I. John Niemkiewicz, design engineer. In addition to cutting costs by more than one-third, the arc-welded design is more reliable and simpler to manufacture. It solved problems caused by the necessity of using various construction materials, holding close tolerances, controlling distortion, and joining thin to thick sections. The award—and others, totalling $25,000—was given by the James F. Lincoln Arc Welding Foundation, Cleveland.

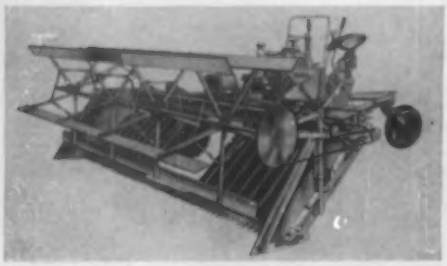




Comfort for a long haul is built into the Glide-Ride suspension truck seat by the Freedman Seating Co., Chicago. Shock-free seat suspension is built to eliminate "back-slap" and all metal-to-metal contact. Height and tilt are adjusted by the four-way scissors pedestal. The suspension unit is an aluminum extrusion.

Industrial Design

comments and configurations





A new Owatonna windrower, evolved from a "somewhat hodgepodge-looking" model (above), was envisioned by S-P-G in the design sketch at right. The actual machine, below, bears a strong resemblance to the drawing.







The control station underwent major changes as the "precarious-looking affair" on the old windrower gave way to a more efficient and secure design. The new seat increases comfort but not cost.

Restyling an "efficient, rugged, but somewhat hodgepodge-looking" windrower—for production with metal breaks, shears, and weldments—was a recent assignment for the industrial design firm of Scharfenberg-Polivka-Gale Inc., Hopkins, Minn. Manufacturer is Owatonna Mfg. Co., Owatonna, Minn., a small producer of self-propelled windrowers and other farm equipment. The design procedure, summarized below, was described at a recent meeting of SAE.

Redesign began at the control station (left, below). For the first time, parts were designed to be common to all models in the line. A platform was mounted beside the engine, and all controls except the two steering handles were placed on a console at the operator's right. The console also shields the operator from heat of the engine. The seating arrangement was changed from an off-the-shelf seat and a comparatively expensive spring to a foam-padded seat made by OMC from tubing and sheet metal, mostly scrap pieces.

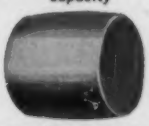
Support beams for the trailing wheel are made from sheet metal instead of the former, more costly welded pipe; a belt guard adds to appearance and safety; and the reel, which had looked "like the business end of an old stern-wheeler" is now light-gage metal instead of angle iron. The new reel is more solid looking, requires fewer parts, and costs less.

From "Farm Equipment: A Growing Challenge for the Industrial Designer," by John Gale, G. T. Scharfenberg, and J. N. Polivka, presented at the Heavy-Duty Vehicle Meeting of the Society of Automotive Engineers, Milwaukee, Sept. 11-14, 1961.

When selecting roller bearing pillow blocks, remember

it's what's inside that counts!

MAXIMUM SIZE AND NUMBER OF ROLLERS for highest capacity



CENTRIFUGALLY CAST, PRECISION MACHINED BRONZE RETAINERS for smooth, quiet operation



HIGH, HEAVY INNER RING FLANGES for ease of installation and removal



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Link-Belt spherical roller bearing pillow blocks are self-aligning. Available in adapter mounting and direct-shaft mounting types for shafts from 1 7/16" to 12". Choice of two effective seals: all-purpose steel, multi-labyrinth seals, or Dacron-contact seals.

For full details, call your nearest Link-Belt office. Look under BEARINGS in the yellow pages of your telephone directory. Ask for Book 2760.



SERIES 6800, 6900, 7800, 7900 have exceptionally rugged, two piece housings—machined as two perfectly matched parts providing easy installation.



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LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Warehouses, District Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney) Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 18,414-A

Industrial Design

comments and configurations

In accepting a design award for the 1962 Valiant, Virgil M. Exner paid tribute to the artistic taste of the American consumer. Mr. Exner, vice president and director of styling, Chrysler Corp., told the Society of Illustrators, "I believe the design quality of American products is improving constantly because our work is being judged every day by some of the most astute part-time art critics in history." The society's Styling Award was presented to Mr. Exner for the design of the Valiant Signet 200 hardtop. This is the second automobile thus honored in the 30-year history of the award. Mr. Exner also commented:

"The rapidly improving artistic taste of the American consumer puts exacting demands on today's product designers, but it also gives them a powerful incentive to create better design. Because they know they are designing for a market which more and more rejects poor design, their efforts are directed away from superficial tricks and toward those forms which embody sound aesthetic principles.

"The artistic sensitivity and skill that go into the design and manufacture of many products around us today have, in my opinion, contributed greatly to the expansion of industry and to the economy of America.

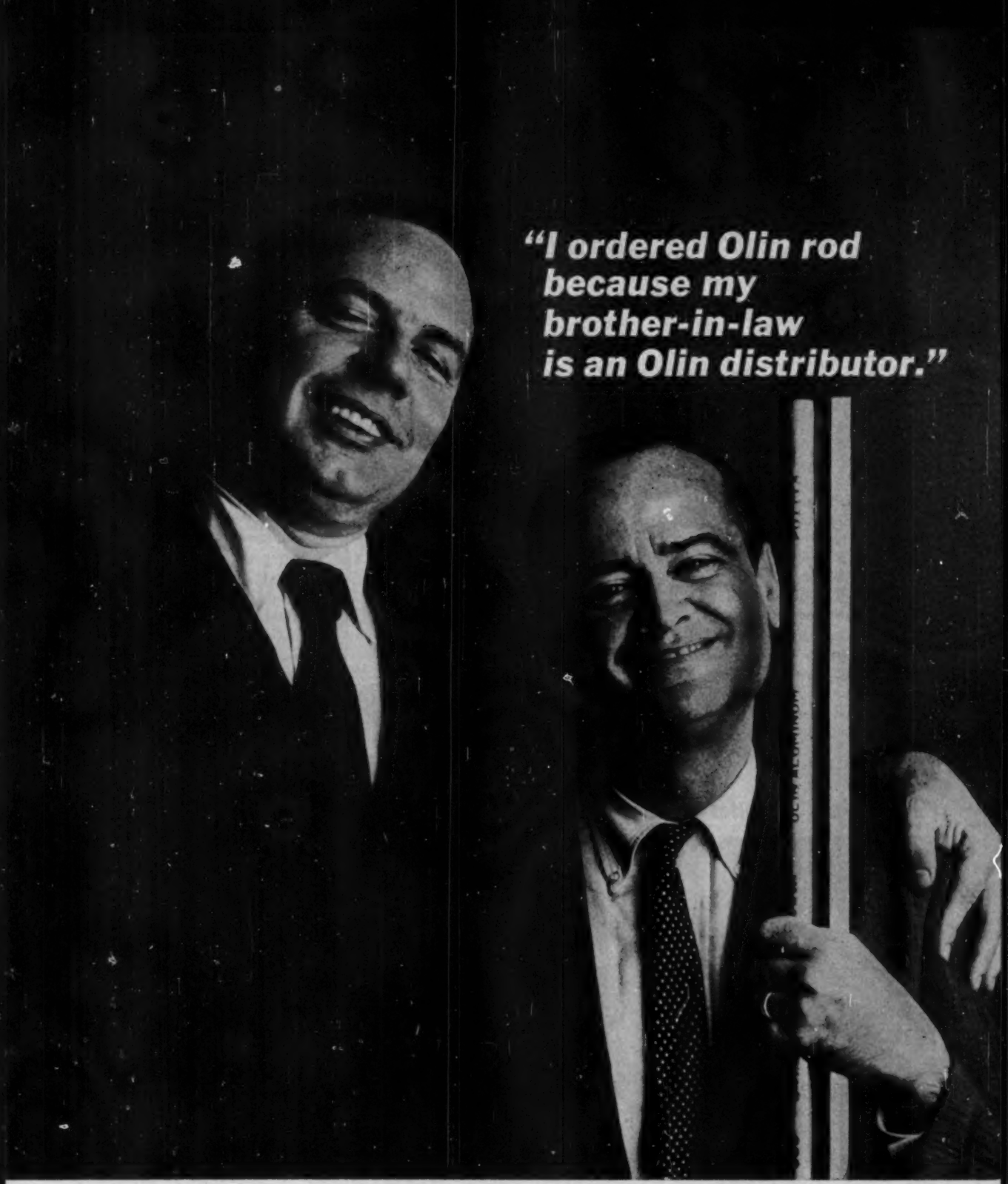
"Industrial design can be defined as the application of taste, character and logic to the products of machinery. It is a means of creating attractive commodities which work better because they are designed to work better. The combination of improved appearance and performance makes them attractive to consumers whose purchases certainly are the essential force that keeps the wheels of industry turning."





Mr. Exner employs what he calls the "directed-motion" approach to automotive styling: "A designer should strive to make the car appear poised to go somewhere." The standard 50-50 proportion between hood and rear deck was changed in the Valiant so that "about 60 per cent of the focus lines directed forward."



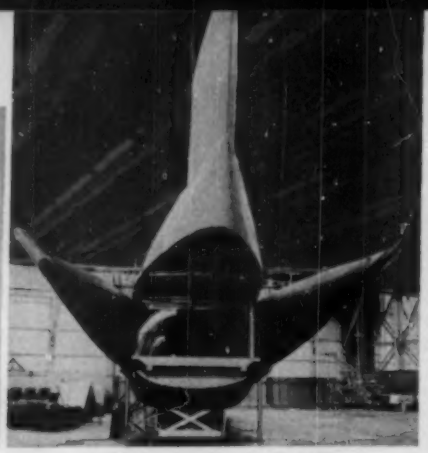


"Sentiment? Not a bit! Common sense. Smartest thing George ever did was to tie in with Olin. Smartest thing I ever did was to use Olin Aluminum rod and bar. I had an Olin consultant take a look at my screw machine operation. He showed me how Olin's exclusive cold processed aluminum rod would give me a better end product because of its sound structure and excellent finishing qualities—and up my production rate per hour. Actually, my brother-in-law recommended the Olin consultant. How many brothers-in-law have come up with ideas that can save a guy up to 30% on finished parts?" **Nobody thinks in aluminum better than Olin. Want to talk to our consultants? Call your local Olin Aluminum Sales Office or Distributor.**

Olin
ALUMINUM

Circle 216 on Page 19





'63 Roll-Out Scheduled for Turbofan Transport

MARIETTA, GA.—T-tail empennage, high wing configuration, and fuselage-mounted landing gear provide a truck-level cargo compartment in Lockheed Aircraft's forthcoming C-141 jet transport. The turbofan-powered freighter has been ordered by MATS (Military Air Transport Service) to bolster U. S. strategic airlift capability. Roll-out and flight tests are scheduled for 1963.

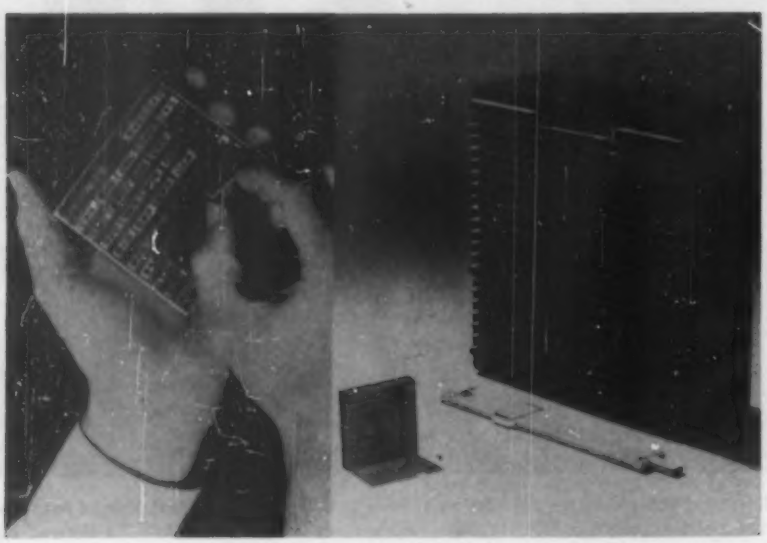
After military orders are filled, Lockheed will be free to offer the FAA-certified craft to commercial air-freight lines. The civilian version is named "Lockheed 300."

C-141's loading system, an integral part of the fuselage, consists of rollers and restraining rails (for pallets) which can be quickly retracted into recesses to provide a flat, smooth floor suitable for bulk loading, rolling stock, troops, and litter patients. Cargo floor is capable of withstanding a 20,000-lb single-axle load, and will accept rolling loads imposed by a 31,750-lb armored assault vehicle.

Four pod-mounted Pratt & Whitney TF 33-P-7 turbofan engines, rated at 21,000 lb thrust each, will give the C-141 a maximum cruising speed of 550 mph. Cruise altitudes will range to 45,000 ft.

C-141 Size and Performance	
Length (ft)	146.2
Height (ft)	39.1
Wingspan (ft)	160.7
Weight, empty (lb)	124,800
Takeoff weight, max (lb)	315,000
Payload, max (lb)	93,000
Range with max fuel and payload (mi)	5800
Payload with max fuel (lb)	40,000
Passenger capacity, max	151
Takeoff, FAA field length (ft)	6000
Speed, cruise/max (mph)	506/550

Pocket-Size Computer Outworks a Desk Calculator



By designing with semiconductor networks, TI engineers came up with a tiny general-purpose computer (left) that does the same job as a much larger conventional one (right). The networks improve equipment reliability by minimizing connections and eliminating the need for individually packaged components. High-density packaging problems involving thermal dissipation and electrical interaction have now been solved, according to the company.

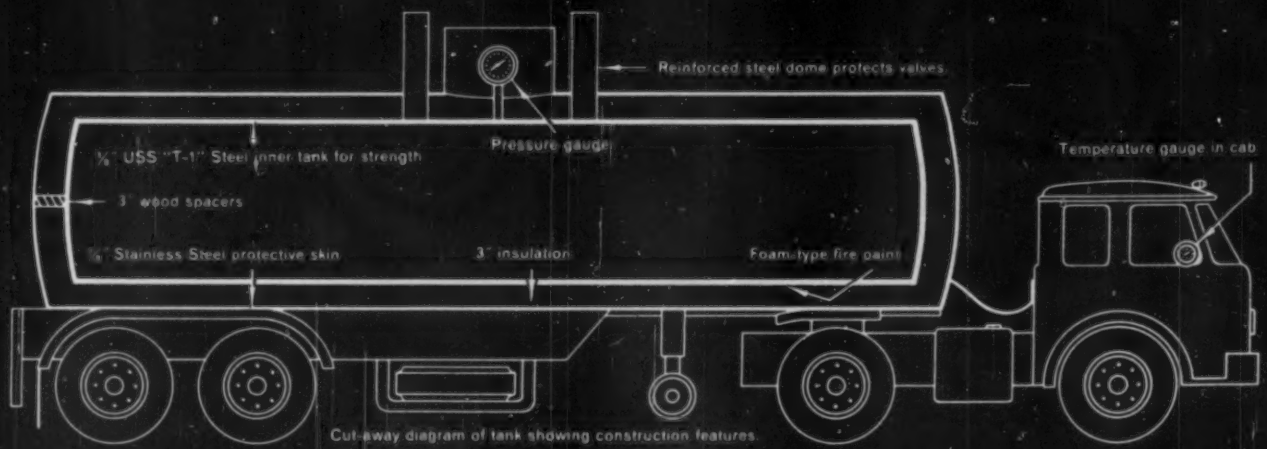
DALLAS, TEXAS—A general-purpose digital computer that's not much bigger than a cigarette pack does the same job as a conventional model 150 times its size. Developed by Texas Instruments Inc., the device was demonstrated for the Air Force last month.

Set up to simulate a desk calculator, the 10-oz, 6.3-cu-in. computer competed against a larger (480 oz, 1000 cu in.) machine that was programmed to handle addition, subtraction, multiplication, division, and square-root problems.

The microminiature computer uses semiconductor networks, rather than individual components. The networks, called Solid Circuit networks by TI, consist of 587 digital circuits, each formed within a minute bar of silicon. The conventional computer requires 8500 components.

Hermetically sealed, the $\frac{1}{4}$ x $\frac{1}{8}$ x 1/32-in. networks were assembled by welding from 8 to 16 in a stack and then encapsulating the stack to form a rigid module.

This mark tells you a product is made from modern, dependable Steel.



Cut-away diagram of tank showing construction features

"Untruckable" chemical now hauled safely by USS "T-1" Steel-Stainless Steel tank truck

Liquid ethylene oxide boils at 51.3°F. The vapors are highly flammable and explosive. Until a year ago, it was considered unsafe for delivery by tank truck.

Today, regular deliveries are being made with a special tank truck that's like a huge steel vacuum bottle. The unit was designed and fabricated by Trinity Steel Company, Inc., of Dallas. The inside tank, holding 5,300 gallons of ethylene oxide, is made from USS "T-1" Constructional Alloy Steel which is three times as strong as regular carbon steel. The outer shell is bright, smooth Stainless Steel which reflects heat, helps to keep the tank cool. In between is a three-inch layer of insulation. Ethylene oxide is loaded at 40°F and the tank is capable of keeping it under 45°F for 24 hours — more than long enough to make the deliveries.

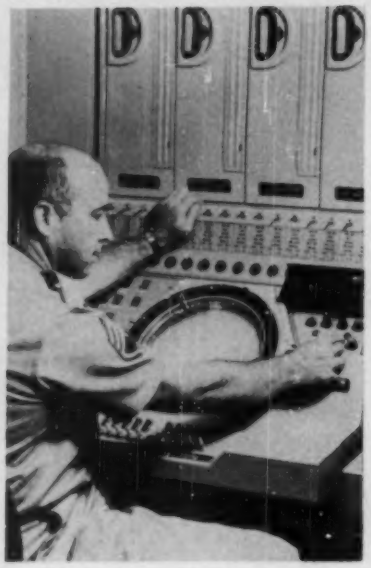
Less weight — more payload. Together with Trinity Steel's design and construction concepts, the great strength of USS "T-1" Steel permitted the use of ⅜-inch plate instead of $^{11}/_{16}$-inch, which would have been required with carbon steel. Tank weight was reduced almost 50%; hence, considerably more payload could be hauled. Delivery costs were thus lower and the savings more than justified the cost of the truck.

Other applications. Because of USS "T-1" Steel's exceptional strength, toughness, and high resistance to impact abrasion, it is widely used to build equipment stronger, but lighter in weight. USS "T-1" Steel is readily weldable, and retains its toughness down to −50°F. Write for a copy of our book, "USS 'T-1' Steel." United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania. Since United States Steel does not build trucks, for specific information concerning special transport requirements, contact such truck builders as Trinity Steel Company, Inc., 4001 Irving Boulevard, Dallas 7, Texas. USS and "T-1" are registered trademarks.

United States Steel Corporation · Columbia-Geneva Steel Division · National Tube Division · Tennessee Coal and Iron Division · United States Steel Supply Division · United States Steel Export Company

USS **United States Steel**





Sweeping in on a mountain battle front, helicopters can land the Army's portable air-defense center and be gone in seconds. The system, able to go anywhere the Army goes, will control Hawk and Nike firings, giving the field commander the capability to destroy any aircraft entering his zone of defense. From the command center (right), operations of the battalion can be co-ordinated by two-way communications with coder-decoders at each battery.

Missile Nerve Center Sinks No Roots

FULLERTON, CALIF.—A new air-defense system can be transported anywhere in the world to co-ordinate the fire of widely dispersed missile batteries. Called Helilift by its developer, Hughes Aircraft Co., the new system can be spot-landed by helicopter in extremely rough terrain. One operational unit has already been delivered to the Signal Corps.

Helilift will be used with Nike and Hawk air-defense missiles, according to C. Harper Brubaker, Hughes vice president. It furnishes the individual commander with the electronic capability for timely coordination and concentration of missile fire power against enemy aircraft. Once landed, it can go into action in minutes.

Each complete Helilift is housed in five or more heavy-duty plastic and aluminum shelters. Individual units consist of one headquarters section, called operations central, and four or more coder-decoder stations. The battalion commander monitors the air battle from the operations-central unit and assigns targets to the missile batteries by sending messages through the coder-decoders. The remote stations, located at widely dispersed missile sites, keep the commander informed on status of each battery.

Topics

Soft-drink shelf life is lengthened by a new ultrasonic machine. An "air eliminator" built by Electronic Assistance Corp. beams sound waves at 22,000 cps through filled bottles to eliminate entrapped air, and carbon dioxide is used as a quick, temporary sealer until the bottles are capped.

• • •

A solid-state sausage sampler will replace a human tester next year at the Krey Packing Co., St. Louis. The company will depend on a computer, leased from National Cash Register Co., to determine the daily mix of types and quantities of meats required to produce sausage having the desired flavor by the most economical means. Mixtures are varied because packers usually have different types and amounts of meats on hand. When it is not formulating sausage recipes, the NCR 315 computer will make pricing and sales analyses, process customer transactions, prepare statements, and make out the company's weekly payroll.

• • •

Bathing Bossy—a daily event for dairy cows, prescribed by law in California—can now be done in 4½ seconds by a machine called a Cowash. The bovine bather, similar in operation to an automatic car washer, was invented by Ted Albers, Artesia, Calif.

Taking the milk to market in throwaway containers is proposed by Harry A. Mead and Lamont Slagel, inventors of a plastic-bag replacement for the 10-gallon milk can. The bags, developed for Dairy Containers Inc., Denver, would be made from a continuous tubular strip of plastic. After being filled, the bags could be heat-sealed or clipped shut, then shipped in cartons. They could be made with spouts.

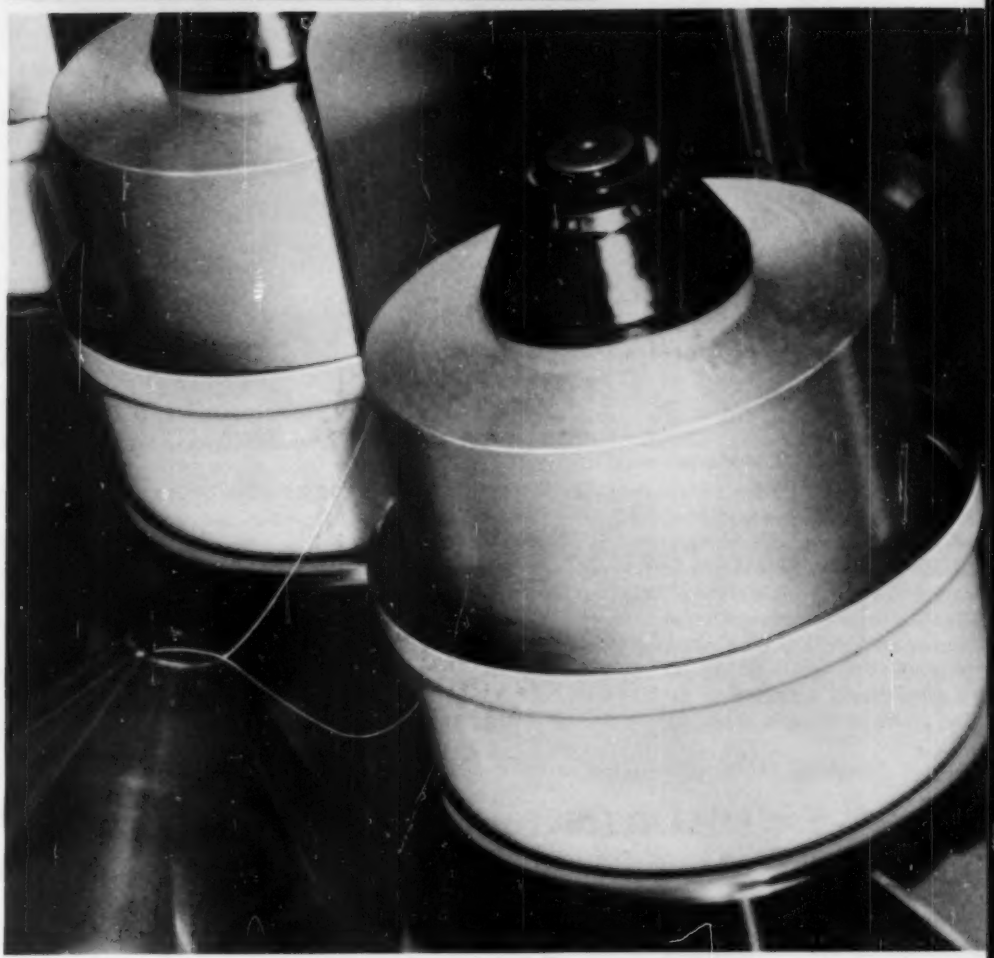
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Vending machines go to school, dispensing notebooks, pens, paper, and other student necessities. More than 22,000 such machines have been placed in schools in 33 states.

Circle 217 on Page 19→

Du Pont **Delrin**

one of Du Pont's versatile engineering materials



New textile supply buckets of DELRIN® last longer... cost less

Large (10 in. diameter, 1¼ lbs.) buckets economically injection-molded of Du Pont DELRIN acetal resin provide Leesona Corporation, Providence, R. I., with a rugged, long-wearing part for their heavy-duty textile machinery.

Evenly wound packages of filament yarn sit within the buckets of DELRIN (shown above) on a multi-spindle Twister-Coner machine. This machine transfers the yarn from the evenly wound spools to cones at a rate of 340 yards per minute.

The bowl-shaped buckets (molded by Crystal Thermoplastics, Inc., Pawtucket, R. I.) are stationary and thus are subject to abrasion and static build-up by friction of the moving yarn. DELRIN resists both—in fact, outwears phenolic resins previously used—and, in addition, DELRIN maintains its dimensional stability in dry or humid environment.

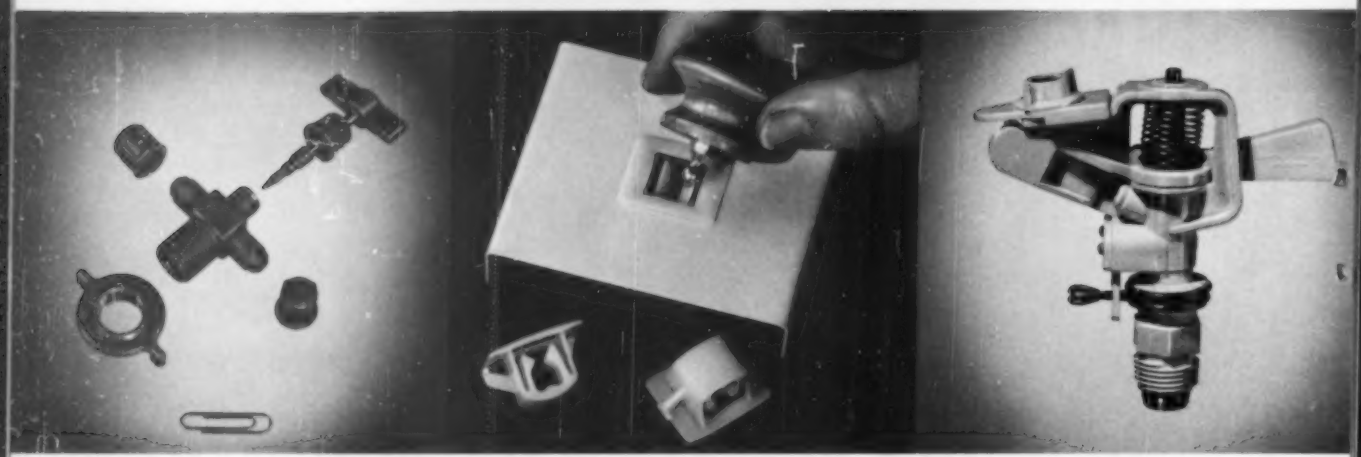
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Delrin

one of Du Pont's versatile engineering materials



CAN TAP VALVE for use with packaged refrigerant containers is molded entirely of DELRIN except for piercing needle. Molded-in threads are strong and clean; caps fit tightly. Parts molded of Du Pont DELRIN do not corrode and maintain their dimensions under a wide range of temperatures and humidity. (Molded by Industrial Plastic Molders, Inc., for Watsco, Inc., both of Hialeah, Florida.)

CABINET CATCHES molded of DELRIN take advantage of the resilient, spring-like properties of this resin to permit easy installation of the catch and to hold the steel strike. Abrasion and fatigue resistance of DELRIN allow long life under repeated cyclic stressing of the retaining fingers. Its natural lubricity permits steel strike to move smoothly. (Made by Amerock Corp., Rockford, Ill.)

LAWN SPRINKLERS molded of tough Du Pont DELRIN resist abrasion from sand and silt. DELRIN offers excellent resistance to corrosion and "lime-up", trouble-free service, excellent thread strength. And a choice of colors is made possible by the integral colors of DELRIN acetal resin. (Molded by Lee Deane Products, Inc., for Plasmet Engineering Co., both of Santa Fe Springs, California.)

DELRIN has strength and toughness

to function reliably under rugged usage. Parts molded of Du Pont DELRIN acetal resin retain a high degree of their mechanical properties under severe environmental conditions, such as high temperatures, moisture, solvents and many corrosive chemicals.

Many designers are taking advantage of the wide range of unique properties of DELRIN, and the substantial cost economies in manufacture and assembly. Why not investigate the possibilities of DELRIN for your product? Mail the coupon below for more information.

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DELRIN *acetal resins*

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Meetings and Shows

Nov. 15-18—

Society of Naval Architects and Marine Engineers. Annual Meeting to be held at the Waldorf-Astoria Hotel, New York. Further information is available from SNAME headquarters, 74 Trinity Place, New York 6, N. Y.

Nov. 16—

National Electrical Manufacturers Association. 35th Annual Meeting to be held at the Plaza Hotel, New York. Further information can be obtained from NEMA headquarters, 155 E. 44th St., New York 17, N. Y.

Nov. 20-21—

Institute of Radio Engineers. Electron Devices Meeting to be held at the Shoreham Hotel, Washington, D. C. Additional information can be obtained from IRE headquarters, 1 E. 79th St., New York 21, N. Y.

Nov. 26-Dec. 1—

American Society of Mechanical Engineers. Winter Annual Meeting to be held at the Statler Hilton Hotel, New York. Additional information can be obtained from Meetings Dept., ASME, 345 E. 47th St., New York 17, N. Y.

Nov. 27-29—

American Management Association. Special Materials Conference to be held at the Savoy-Hilton Hotel, New York. Further information is available from AMA, 1515 Broadway, New York 36, N. Y.

Nov. 27-Dec. 1—

28th Exposition of the Chemical Industries to be held at the Coliseum, New York. Additional information can be obtained from the exposition manager, E. K. Stevens, International Expositions Co., 480 Lexington Ave., New York 17, N. Y.

Nov. 30-Dec. 1—

Institute of Radio Engineers. Vehicular Communications Conference to be held at the Hotel Leamington, Minneapolis. Additional information is available from IRE, 1 E. 79th St., New York 21, N. Y.

Dec. 2-5—

Visual Communications Congress to be held at the Biltmore Hotel, Los Angeles. Sponsors are Society of Reproduction Engineers, American Institute for Design and Drafting, and American Records Management Association. Additional information can be obtained from Congress headquarters, 18465 James Couzens Highway, Detroit 35, Mich.

Dec. 7-8—

Society of the Plastics Industry Inc. Ninth Plastic Film, Sheeting, and Coated Fabrics Conference to be held at the Pierre Hotel, New York. Further information is available from SPI headquarters, 250 Park Ave., New York 17, N. Y.

Dec. 12-14—

Eastern Joint Computer Conference, to be held in Washington, D. C., under the sponsorship of the American Federation of Information Processing Sciences (Institute of Radio Engineers, American Institute of Electrical Engineers, and Association for Computing Machinery). Additional information can be obtained from IRE headquarters, 1 E. 79th St., New York 21, N. Y.

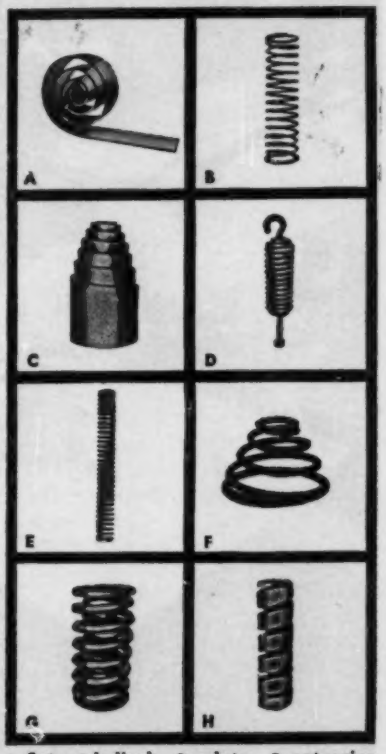
Dec. 12-14 —

American Society of Agricultural Engineers. Agricultural Engineering Exposition and ASAE Winter Meeting to be held at the Palmer



"I don't care if it is their lunch hour . . ."

Can you identify these springs?



A. flat B. helical C. volute D. extension E. helical F. cone G. helical, triple-coil H. rectangular section

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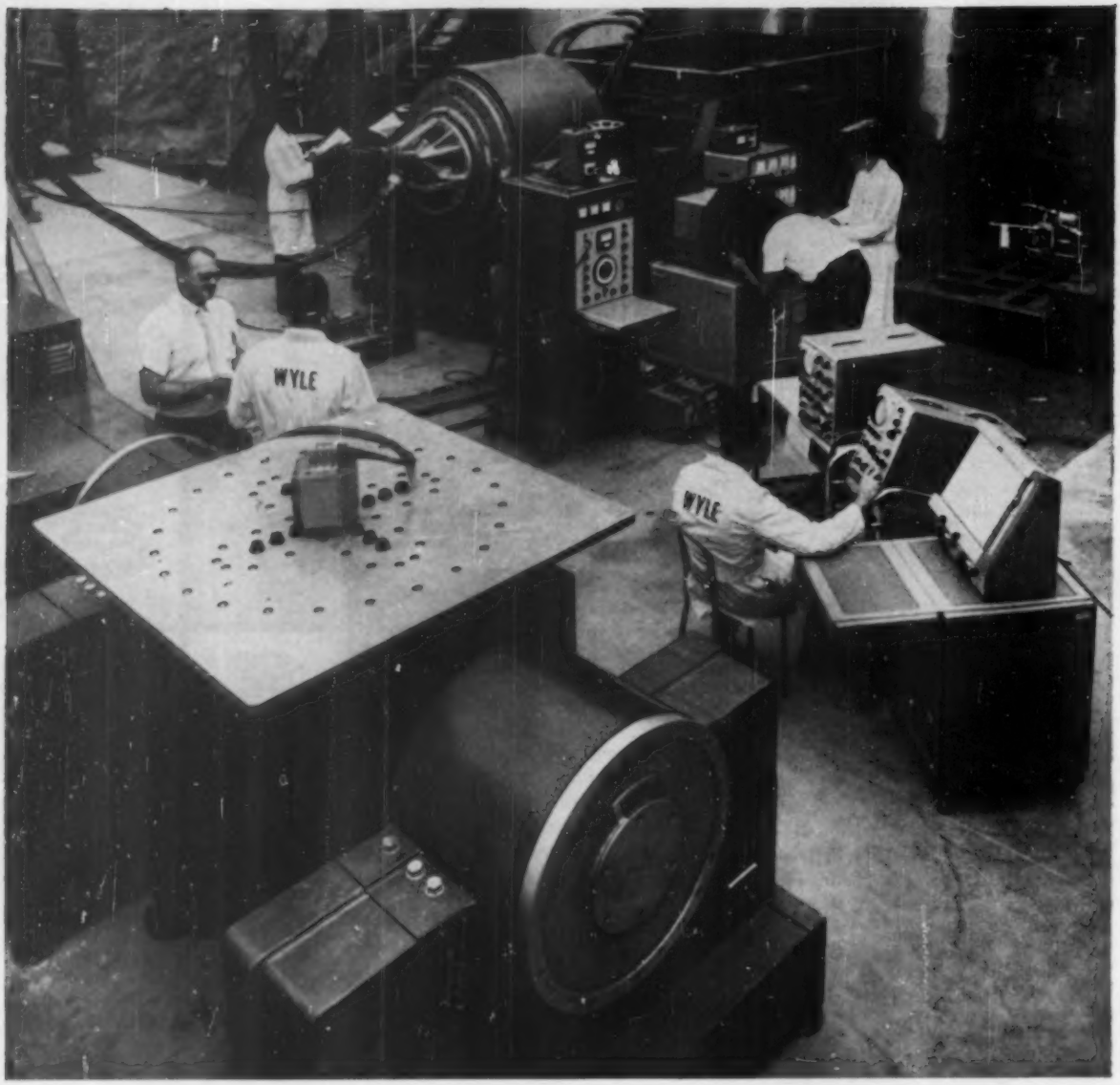
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Circle 218 on Page 19

←Circle 217 on Page 19



NEW LING SHAKER...FIRST INSTALLED AT WYLE LABORATORIES

...takes medium sized packages up to record high "g" levels

Wyle Laboratories, Inc., one of the world's largest independent Testing Laboratories, scores another first with the addition of a new Ling Shaker shown above. To increase its already impressive vibration testing capability, Wyle chose the revolutionary new Ling L-200 Shaker. The L-200 is the first shaker in operation with the capability needed to take a 100 pound package to 100 "g" or a 250 pound package to 60 "g"... and Wyle Laboratories is the first to have this capability, first to offer its customers such a testing service. The L-200, with a force rating of 22,000 pounds, features a unique "X" design armature, weighing only 115 pounds. It provides Wyle with the maximum reliability always associated with Ling equipment, and the ability to take their customers' packages of up to 100 pounds to 100 "g". Wyle facilities also include the powerful Ling Model 249 Shaker, pictured in the background, with a force rating of 30,000 pounds... additional evidence that Wyle relies on Ling for the finest vibration test equipment. For more information on Ling Systems, write Department MD-1161 at the address below.

LTV
LING-TEMCO-VOUGHT, INC.

LING ELECTRONICS DIVISION

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Circle 221 on Page 19

LING ELECTRONICS

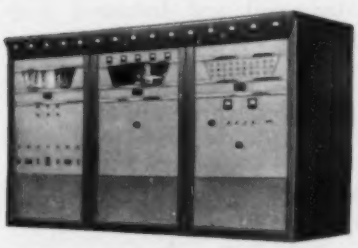
At Wyle Laboratories — and other first class environmental testing installations—you'll find Ling provides the most reliable and complete line-up of Vibration Testing Systems.

Ling was first to conceive and build high power amplifiers to drive electro-dynamic shakers. The Model PP120/150 Power Amplifier shown below, rated at 120,000 VA and engineered to drive 22,000 and 30,000 pound shakers, is another example of Ling's forward-looking engineering.

Three compact cabinets house everything —transformers, water-cooled heat exchanger, field supply, armature protector, controls and metering.

No console is required because all control circuitry is included in the cabinet — though duplicate controls in a console can be used when remote control is desired.

Safety, easy inspection and maintenance are engineered in — the amplifier features a foolproof interlock system, instantaneous overload protection and walk-in accessibility at the rear of the cabinet. Like all Ling Amplifiers, this 120,000 VA water-cooled model is designed, built and rated for continuous operation at full output.



Remember that whatever your needs in super power electronics—vibration testing, acoustics or sonar, Ling engineering sets the industry standard with designs of highest reliability, highest performance and longest life.

LTV

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LING ELECTRONICS DIVISION

HIGH POWER ELECTRONICS FOR
VIBRATION TESTING · ACOUSTICS · SONAR

House Hotel, Chicago. Further information can be obtained from society headquarters, St. Joseph, Mich.

Dec. 18—

Institute of the Aerospace Sciences. Wright Brothers Lecture to be given at the Smithsonian Institution, Washington, D. C. Additional information can be obtained from IAS, 2 E. 64th St., New York 21, N. Y.

Jan. 8-12—

Society of Automotive Engineers Inc. 1962 Automotive Engineering Congress and Exposition to be held at Cobo Hall, Detroit. Additional information can be obtained from society headquarters, 485 Lexington Ave., New York 17, N. Y.

Jan. 22-24—

Institute of the Aerospace Sciences, Thirtieth Annual Meeting to be held at Hotel Astor, New York. Further information can be obtained from IAS headquarters, 2 E. 64th St., New York 21, N. Y.

Jan. 22-25—

National Plant Engineering & Maintenance Show to be held at Convention Hall, Philadelphia. Further information can be obtained from show managers, Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

Short Courses and Symposia

Nov. 28-29—

Seminar on Direct Energy Conversion Systems to be held at the University of Wisconsin. Additional information is available from Engineering Institutes, 3030 Stadium, University of Wisconsin, Madison 6, Wis.

Dec. 6-7—

Seminar on Electric Machining and Forming (Electro Metal Removal) to be held at the Statler Hilton Hotel, Hartford, Conn., under the sponsorship of American Society of Tool and Manufacturing Engineers. Further information is available from Gilbert E. Seeley, Education Director, ASTME, 10700 Puritan Ave., Detroit 38, Mich.

Dec. 7-8—

Mechanical Engineering Refresher Course to be given at the University of Wisconsin. Further information can be obtained from Engineering Institutes, 3030 Stadium, University of Wisconsin, Madison 6, Wis.

Dec. 11-13—

Metal Joining Symposium to be held at Pennsylvania State University. Papers presented on each of the three days will follow a particular theme: High-strength and high-temperature brazing alloys, high-strength material welding, and stress analysis of joints. Advantages and limitations of the various joining methods will be discussed. Panel discussions and question periods will be held each day. Further information is available from Conference Center, Pennsylvania State University, University Park, Pa.

Dec. 12-13—

Seminar on Nondestructive Testing to be held at the University of Wisconsin. Additional information is available from Engineering Institutes, 3030 Stadium, University of Wisconsin, Madison 6, Wis.

Jan. 9-11—

Eighth National Symposium on Reliability and Quality Control to be held at the Statler Hilton Hotel, Washington, D. C. Technical sessions will cover reliability and design techniques, reliability prediction and measurement, mathematics and reliability models, statistical techniques, reliability testing, maintainability, quality control and reliability, reliability programs and management, reliability and quality control education, and reliability training sessions. Additional information can be obtained from Mr. A. R. Park, Mail Stop No. 729, Westinghouse Electric Corp., P. O. Box No. 1897, Baltimore 3, Md.

Jan. 11-12—

Electrical Engineering Refresher Course to be held at the University of Wisconsin. Further information is available from Engineering Institutes, 3030 Stadium, University of Wisconsin, Madison 6, Wis.

Jan. 24-26—

Second Symposium on Thermo-

Shaft Seals That Cut Original Equipment Costs



Every problem of the manufacturer has been taken into consideration—from production line requirements to the cost of components in the pricing of the end product.

THESE ARE SOME OF THE ADVANTAGES YOU CAN PLAN ON WHEN YOU USE JOHN CRANE PRODUCTION SHAFT SEALS:

ECONOMY—Low unit cost is achieved through mass production methods.

FAST, EASY INSTALLATION—Unit construction permits them to be quickly pressed into position.

MINIMUM STOCK—Four sizes, ⅜", ½", ⅝" and ¾" can be used for all intermediate shaft diameters to ¾"

ALL SERVICE CONDITIONS—Only three types are needed to cover all services . . . water to destructive acids, temperatures from −100° to +500°F. . . . pressures to 150 psi.

RECOMMENDATIONS AND ASSISTANCE—Tell us about your requirements. We will be glad to give recommendations or provide assistance.



For general information ask for Bulletins S-216 and S-205-3.

Crane Packing Company, 6425 Oakton Street, Morton Grove, Ill. (Chicago Suburb).
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physical Properties to be held in Princeton, N. J., under the auspices of the Heat Transfer Div. of the American Society of Mechanical Engineers. Further information can be obtained from ASME headquarters, 345 E. 47th St., New York 17, N. Y.

Jan. 29-Feb. 2—

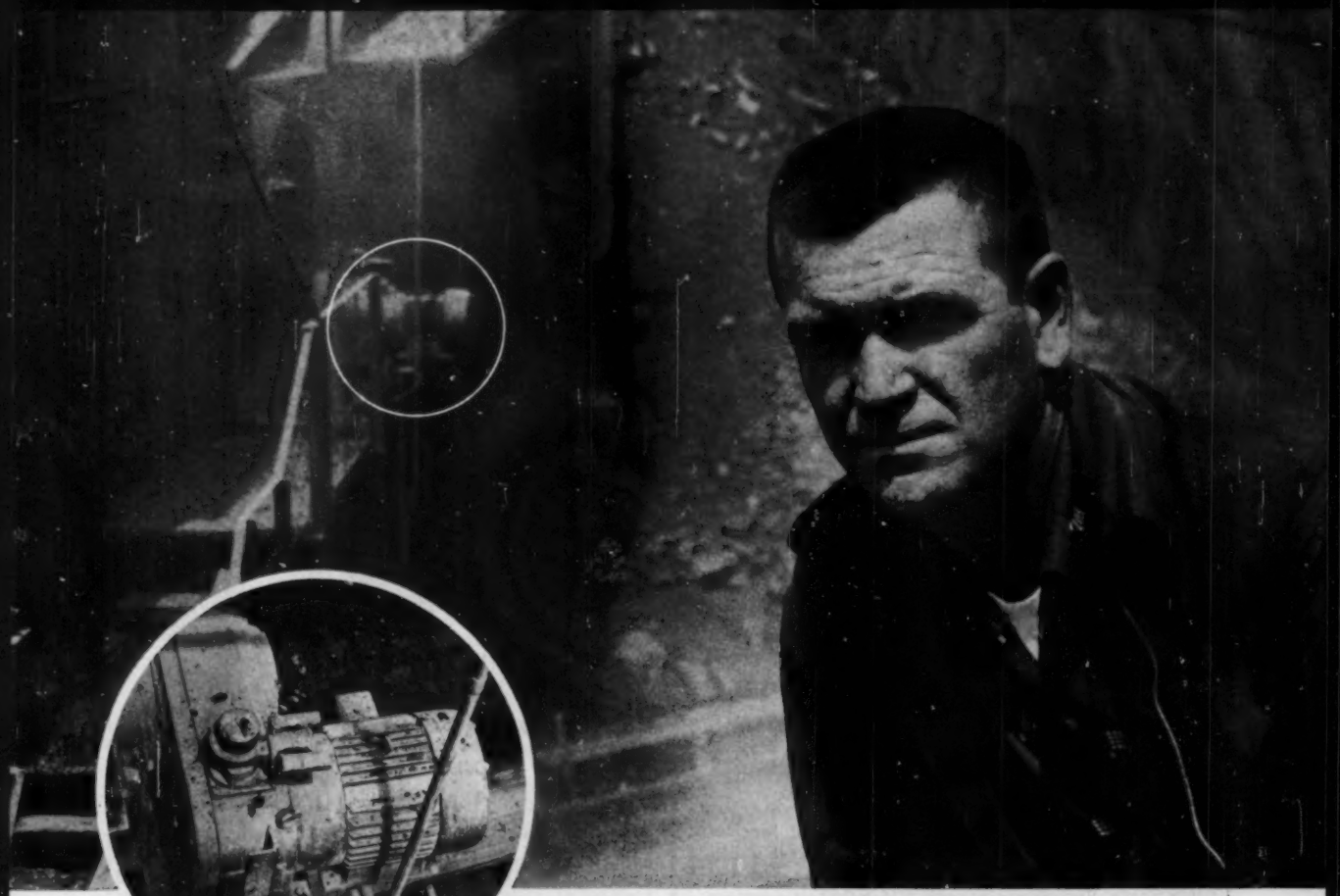
Short Courses on Measurement Engineering to be held at Arizona State University. Theme of the courses is "How To Obtain Valid Data on Purpose;" they consist of a lecture program and a concurrent experimental program. About half of the lectures are on basic physical principles on which transducers are based and on fundamental measurement theory, including static and dynamic system behavior and the correlation between them. The other lectures are devoted to measurement problems and approaches in specific areas. Additional information is available from Prof. Peter K. Stein, Associate Professor of Engineering, Measurement Engineering, Engineering Center, Arizona State University, Tempe, Ariz.

Jan. 29-Feb. 8—

Short Course on Quality Control by Statistical Methods to be held at the University of Illinois. Additional information can be obtained from University of Illinois, Dept. of Mechanical and Industrial Engineering, Urbana, Ill.



"He has what it takes to argue with the boss—a private income."



Richard Branch, superintendent at Red Rock Quarry, Nesquehoning, Pa.

"Since installation in July, 1960 . . .

Constant, Heavy Impact Hasn't Stopped Our General Electric Polydyne® Drive"

"Since we installed a General Electric Polydyne mechanical adjustable-speed drive on our Universal Wobbler Feeder, we haven't had a moment's downtime due to malfunction since July, 1960," says Richard Branch, superintendent at Red Rock Quarry, Nesquehoning, Pa.

The wobbler's elliptical bars convey large rocks to a crusher and let fines and dirt drop through to another conveyor. The rock is unusually hard sandstone, which stratifies into large, thin pieces. This type of material creates a tremendous strain on the drive unit during initial impact and separation.

"THE FORMER DRIVE cost us $2,939 in maintenance and eight days' lost production during the year and a half we used it," continues Mr. Branch. "General Electric's Polydyne Drive is 15 horsepower, same capacity as the old one, but it's physically larger and much stronger. It has proved itself an excellent solution for our tough operating conditions."

When your application requires low-cost adjustable speed, reliability, and ease of maintenance, investigate General Electric Polydyne Drives. Ask your G-E Sales Engineer or write for bulletin GEA-6806, Section 854-07, General Electric Co., Schenectady 5, N. Y.

GENERAL ELECTRIC

GENERAL ELECTRIC OFFERS A COMPLETE LINE OF LOW-SPEED DRIVES, 1/8 TO 200 HP

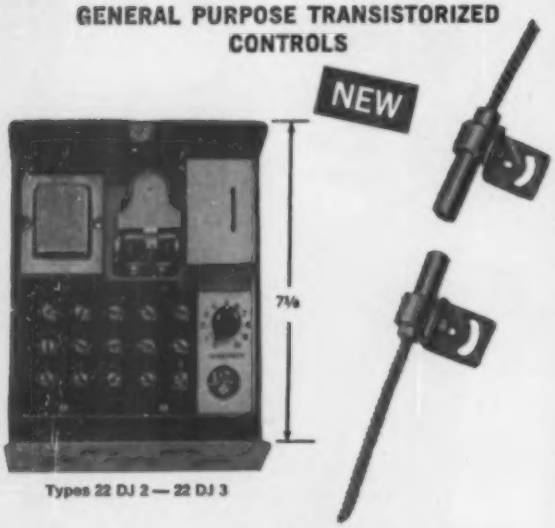


Circle 220 on Page 19

NEW and Important Advances

for Conveyors, Packaging, Most Any Industrial Control Job...

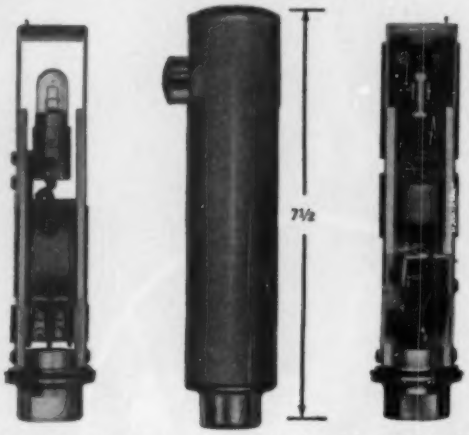
GENERAL PURPOSE TRANSISTORIZED CONTROLS



Types 22 DJ 2 — 22 DJ 3

With light source and semiconductor photocell receiver combinations in standard or miniature sizes to solve varied problems of long range, high sensitivity, high speed and limited space. End view, side view and reflective scanners available. Highly versatile on-off and time-delay control for sorting, positioning, detecting, conveyor jam control and many more industrial applications.

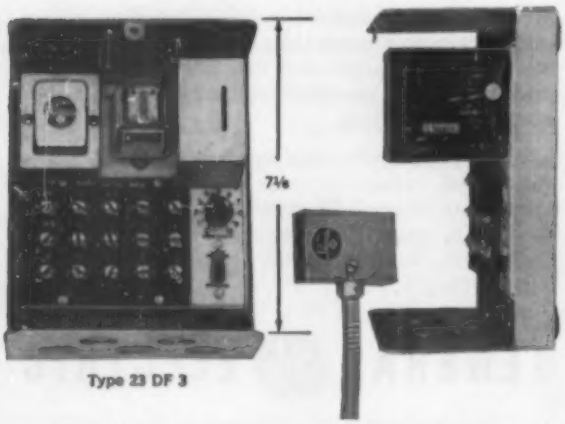
NEW COMPACT, TRANSISTORIZED TUBULAR CONTROLS



Light Source Type 40 CE 1 — On-Off Control Type 22 LB 5

Ingenious, extremely compact easy-to-install design. Ideal for conveyor use and many other jobs such as counting, sensing, positioning, limit switch replacement. On-off and adjustable time delay models available. Priced for tight budgets. No vacuum tubes mean no heat, practically no maintenance. Weathertight housing. Speed to 1200 operations per min. Ranges to 20 ft.

NEW TRANSISTORIZED HIGH-SPEED REGISTRATION CONTROLS



Type 23 DF 3

A better control answer for packaging machinery registration, printing register control, precise cut-off, coding, sorting and high-speed sensing of small objects. Responds to 1 millisecond light or dark pulse. Detects light changes as low as 5%. Operates from reflected light or transmitted light. Scanner, little larger than cigarette lighter, covers full range of color combinations.

TOUGH — PROBLEM SOLVER



Type 22 TF 5

Weatherproof. Employs infrared-sensitive cell and modulated invisible beam to provide exceptional performance up to 1000 ft. Receiver responds to light interruptions as short as 5 milliseconds. Detects heated objects as low as 350°F. Plug-in chassis. A success in paint spray booths under high ambient light. Problem solver in foundries. Fine for intrusion alarms, automatic door and vehicle control. What is your tough application?

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Only PHOTOSWITCH E C A *gives you this 5-POINT ASSURANCE of Superiority*

PROVED PRODUCTS FOR OTHER AUTOMATION NEEDS

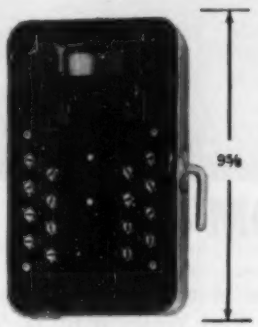


LIQUID LEVEL CONTROLS

For all conductive liquids. Low voltage probes. Choice of magnetic or electronic amplifier. No moving parts in tank. Answers the need for economical container filling, pump control, liquid metering and mixing, high or low level alarm, pilot relay detection and scores of similar level control problems.



Type 13 DJ 3



Type 30 HL 1

ELECTRONIC TIMERS

Timing range from 1/20 second to 4 minutes. Combines precise accuracy and repeatability with complete versatility — interval timing, delayed action, repeat cycle, prolonged intervals, all with a wide variety of initiating circuits.

MOST EXPERIENCE For 25 years the specialist in engineering and producing industrial photoelectric and electronic controls, employing the latest semiconductor techniques. Photoelectric controls are our business, not a sideline.

BEST SELECTION From the broadest, most versatile line of controls your photoelectric switching needs can be fully satisfied. Simply and quickly, too, with "in-stock items", instead of costly and time consuming "specials".

MORE JOB-PROVED CONTROLS Over 100,000 installations of ready-to-use Photoswitch Controls are the best proof of merit and reliability.

CHOICE OF EXPERT BUYERS No other controls are repeatedly chosen by so many of the big, expert buyers in the material handling, packaging, food, beverage, chemical, textile, automotive industries.



UNEQUALED TECHNICAL HELP Near you, as the map shows, is one of 150 Photoswitch experts, with years of experience in application of controls and design of complete, integrated control systems. Backing up these local men are 5 Factory Area Offices and the factory engineering staff.

WRITE for address of Photoswitch office near you. It will pay to get acquainted with the most capable service set-up in the photoelectric control business.

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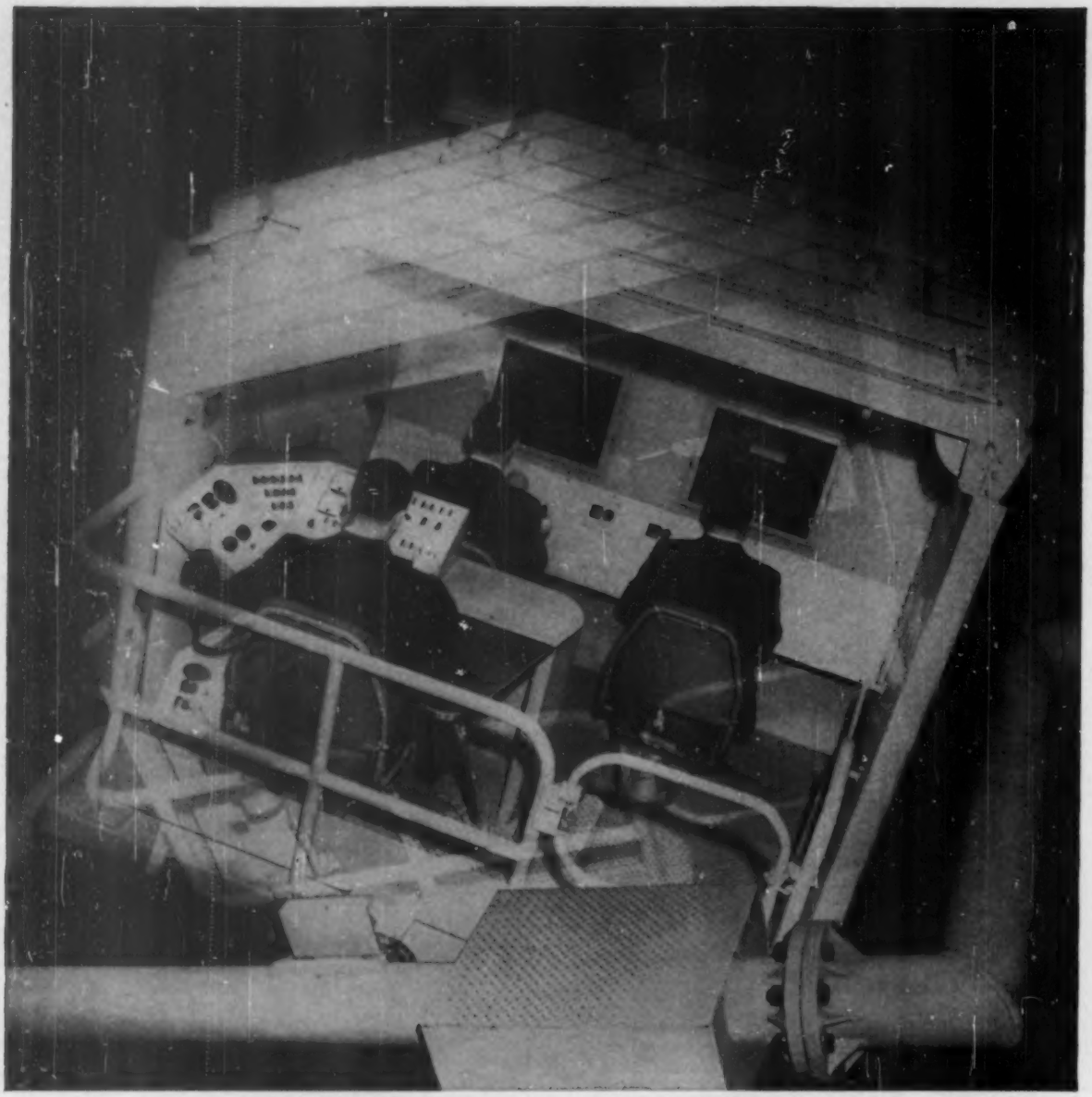
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Circle 222 on Page 19



SUBMARINERS' CLASSROOM

This rolling cab is training atomic submariners. They're learning on land what to expect deep underseas.

The cab is mounted on gimbals, and simulates the control center of atomic subs of the Skipjack class.

Trainees sit forward. Behind them is the instructor, who feeds maneuvering and emergency problems into an analog computer. As the instruments facing the trainees record the problem, the whole cab swings into a realistic imitation of a sub underwater.

Thus crews are tuned to split-second response. The sub simulator is in operation at the U. S. Navy Submarine School at New London, Conn. We designed, built and delivered it under contract to the U. S. Naval Training Device Center, Port Washington, N. Y.—ahead of schedule and within cost.

Republic produced a low cost device emphasizing versatility and low maintenance. How was it done? Credit Republic's broad experience with control systems and analog computer simulations.

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Circle 223 on Page 19

NEW



NORGREN PRECISION PRESSURE REGULATOR

high sensitivity and exact accuracy of air pressure regulation

The new Norgren Precision Pressure Regulator, Type 20AS, is designed for air-gauging, laboratory use, pilot regulation and other applications where a high degree of accuracy and sensitivity is required for air pressure regulation. Operation of the new Type 20AS regulator is characterized by the following:

1. **Accurate regulation at all flows up to the maximum flow recommended for ¼" pipe. This is more than 2 times the flow previously possible with instrumentation regulators.**
2. **Immediate response and high sensitivity.**
3. **Exact repeatability and freedom from drift over short or long time operations.**
4. **Accurate regulation—even at delivery pressures below 1 psi.**

SPECIFICATIONS:

0-60 psig secondary pressure
0-150 psig primary pressure
32° to 160° F temperature range
¼" pipe size

This regulator was demonstrated at our booth in the
Design Engineering Show
Detroit, May 22-25.

For complete technical information about the new Norgren Precision Pressure Regulator, call your nearby Norgren Representative listed in your telephone directory—or write factory for brochure NA-7.

Founded in 1926

C. A. NORGREN CO.

3442 SOUTH ELATI STREET • ENGLEWOOD, COLORADO

Circle 224 on Page 19

Gasket engineering

TORQUE SEQUENCE VS. BOLT LOADS

Studies with new washer-type force gauges show how distribution of total bolt load on flanges is affected by torquing sequence, and how distribution varies with the amount of the load.

E. M. SMOLEY, Research Physicist, Armstrong Research and Development Center

To insure a seal on a gasketed joint, it is important not only that flange pressures be adequate but that these pressures be distributed as uniformly as possible around the flange.

One of the factors affecting distribution of flange loads is the sequence in which bolts are torqued. This problem was recently studied by engineers at the Armstrong Research and Development Center.

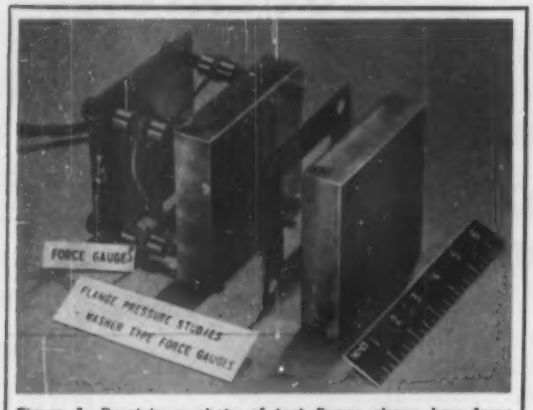


Figure 1. Breakdown photo of test flange shows how force washers were used to measure distribution of bolt loads. Gauges are between load sleeves.

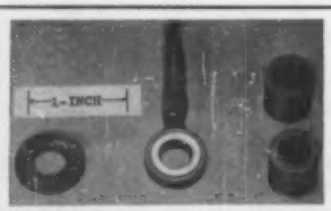


Figure 2. Washer-type force gauge compared with standard flat washer. Load sleeves at right are used to equalize load. Force gauges supplied by Lockheed Electronics Co., Avionics and Industrial Products Division, 6201 E. Randolph St., Los Angeles, Calif.

The engineers used a test flange which was fitted with a new type of strain gauge called a force washer. (See Figures 1 and 2 and captions) These gauges, no larger than an ordinary washer, were placed on each bolt and wired individually to a recorder that charted the actual loads.

Separate tests were then run, with each bolt tightened to torque wrench readings of 5, 10, 15, 20, and 25 pound-feet. The bolts were tightened as shown in Figure 3.

On the basis of the original torque wrench readings, it would be assumed that the load on each bolt, and the distribution of the total load, would be about equal. Each bolt would then bear about 25% of the total load.

Our tests indicate that this is not true. Actually, the act of tightening one bolt can raise or lower the loading on bolts already torqued.

This is demonstrated by the plot of the force gauge readings in Figure 3. For example, with all bolts torqued to five pound-feet, our force gauges indicate that, in terms of total load, 15% is on bolt #1; 5% on #2; 45% on #3; and 35% on #4.

As the initial torque level is increased, the distribution of the load becomes more equal and each bolt carries more of its planned share. At 25 pound-feet, each bolt is carrying about 25% of the load.

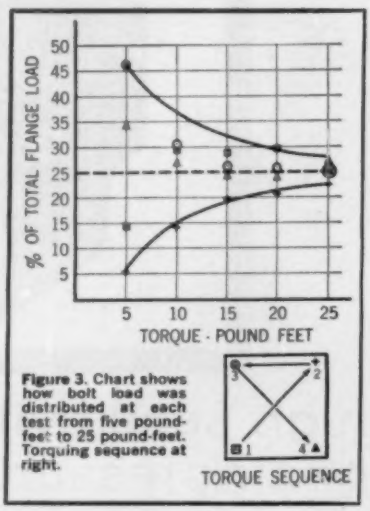


Figure 3. Chart shows how bolt load was distributed at each test from five pound-feet to 25 pound-feet. Torquing sequence at right.

This data confirms previous findings which indicate that the best seals are obtained by using the maximum torque obtainable with a specific flange design. It also has broad practical application in the many instances where bolt torques of 15 pound-feet or less are used.

Studies on the effect of torquing sequence are part of our continuous engineering research on gasket performance. Our large library of data may already contain the answers to your specific sealing problem. We will be glad to make suggestions if you will submit details to us. Write Armstrong Cork Company, 7111 Dean Street, Lancaster, Pennsylvania.

Armstrong GASKET MATERIALS





designing with stainless steel

The ideal design has been described as one in which the properties of the material are fully utilized in the finished product. This ideal is difficult to achieve, and no group of materials comes as close to attaining this ideal as Stainless Steel.

There are over 30 types of Stainless Steel today.

To put it differently, no other material combines so many outstanding properties as the Stainless Steels. Stainless Steels have high tensile strength. All are hardened and made even stronger by cold working. As a family they offer superb resistance to the corrosive effects of an enormous variety of reagents. They have unusual resistance to high temperature oxidation, and are distinguished by relatively low heat conductivity. And on top of their remarkable physical properties, Stainless Steel's lustrous appearance and sales appeal scarcely need mention.

By reflecting the color of its surroundings, Stainless Steel contributes to harmonious design.

The history of Stainless Steel's use is marked by designers who turned a healthy profit with a quality material but mainly with sound ideas. They're the men who used Stainless for its strength and sales appeal in toaster covers, for its appearance and machinability in wrist watches, its structural properties and cleanability in truck trailer parts. Stainless Steel cuts weight and adds years to the life of architectural panels; its corrosion resistance and smooth, pit-free surface have made it the standard of the dairy industry. There are literally thousands of applications of Stainless Steel in which designers have utilized one, two or more of the remarkable properties of Stainless Steel.

Successful designers don't substitute Stainless Steel sections for sections of other materials. They design to Stainless' unique properties.

Good design doesn't stop with function and sales appeal. It must also be capable of economical manufacture. As a comprehensive guide, send for the free book described at the right.

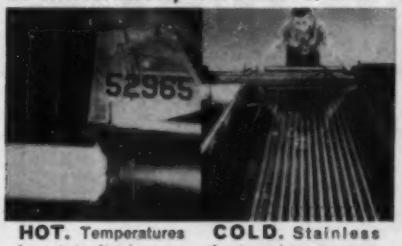
Good design is honest design, whether it uses Stainless Steel or other materials. Yet the fact remains that there is no other commercial material suited to such a varied range of applications as Stainless Steel. The applications shown on these pages are just a few of the hundreds of uses to which Stainless is put every day. To learn more about Stainless Steel and its design properties, call our nearest sales office or write United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

Stainless Steels represent but a few of the thousands of grades of steel in existence today. United States Steel makes a complete line of Stainless Steels as well as alloy, high strength and carbon steels. Bring your design problems to us.

USS is a registered trademark

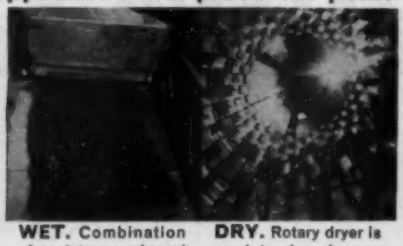
USS **United States Steel**

No material comes close to Stainless Steel's versatility. By way of illustration, here are a few "opposites" that prove our point.



HOT. Temperatures in a jet afterburner reach 1400°F.

COLD. Stainless heat exchanger operates at temperatures as low as —443°F.



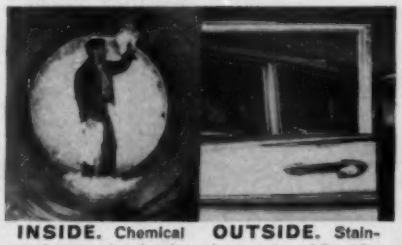
WET. Combination of moisture and coal would corrode nearly anything but Stainless.

DRY. Rotary dryer is used to dry pharmaceutical ingredients.



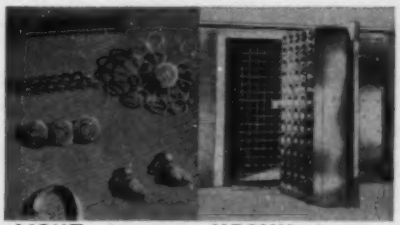
CLEAN. Milk dispensers of Stainless Steel prevent contamination.

DIRTY. Stainless piston rings resist high temperature corrosion.



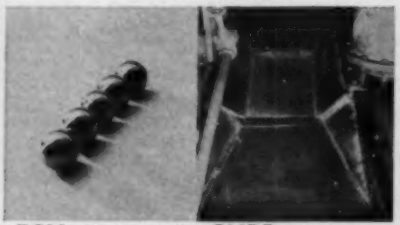
INSIDE. Chemical tanker needs simple wash-out for cleaning.

OUTSIDE. Stainless automobile trim stays bright and good-looking.



LIGHT. Stainless Steel jewelry has a light, graceful appearance.

HEAVY. Strength and hardness of Stainless combine to make safe doors safe.



ROLL. Stainless ball bearings take a lot of punishment.

SLIDE. Abrasion resistance of Stainless Steel makes chutes last longer.



FORM. Stainless Steel wrist watch keeps time and beauty.

FUNCTION. Stainless Steel muffler defies heat with silence.



WATER. Stainless sinks stay bright and beautiful.

FIRE. Stainless Steel shingles inside cat crackers are red hot.

Stainless Steel's properties require close control over processing and in some cases, special fabricating techniques. Its cold working and joining characteristics are of special interest to the designer and will often influence final design. For complete coverage of the subject send for your free copy of our newly revised manual:

FABRICATION OF USS STAINLESS STEEL

Welding Austenitic Stainless Steels • Welding Ferritic Stainless Steels • Welding Martensitic Stainless Steels • Brazing • Joint Preparation Jigs and Fixtures • Removal of Scale from Stainless Steels • Soldering • Joint Design • Lining of Vessels • Riveting • Machining • Cold Cutting Flame Cutting • Cold Forming • Scale Removal Annealing • Hot Forming • Grinding, Polishing and Buffing • Passivation • Cleaning of Stainless Steels • Surface Finishing • Etching • Protection of Stainless Surfaces • Standard Mill Finishes

United States Steel
Room 6144
525 William Penn Place
Pittsburgh 30, Pa.

Send me your new booklet, "Fabrication of USS Stainless Steel."



Name_____

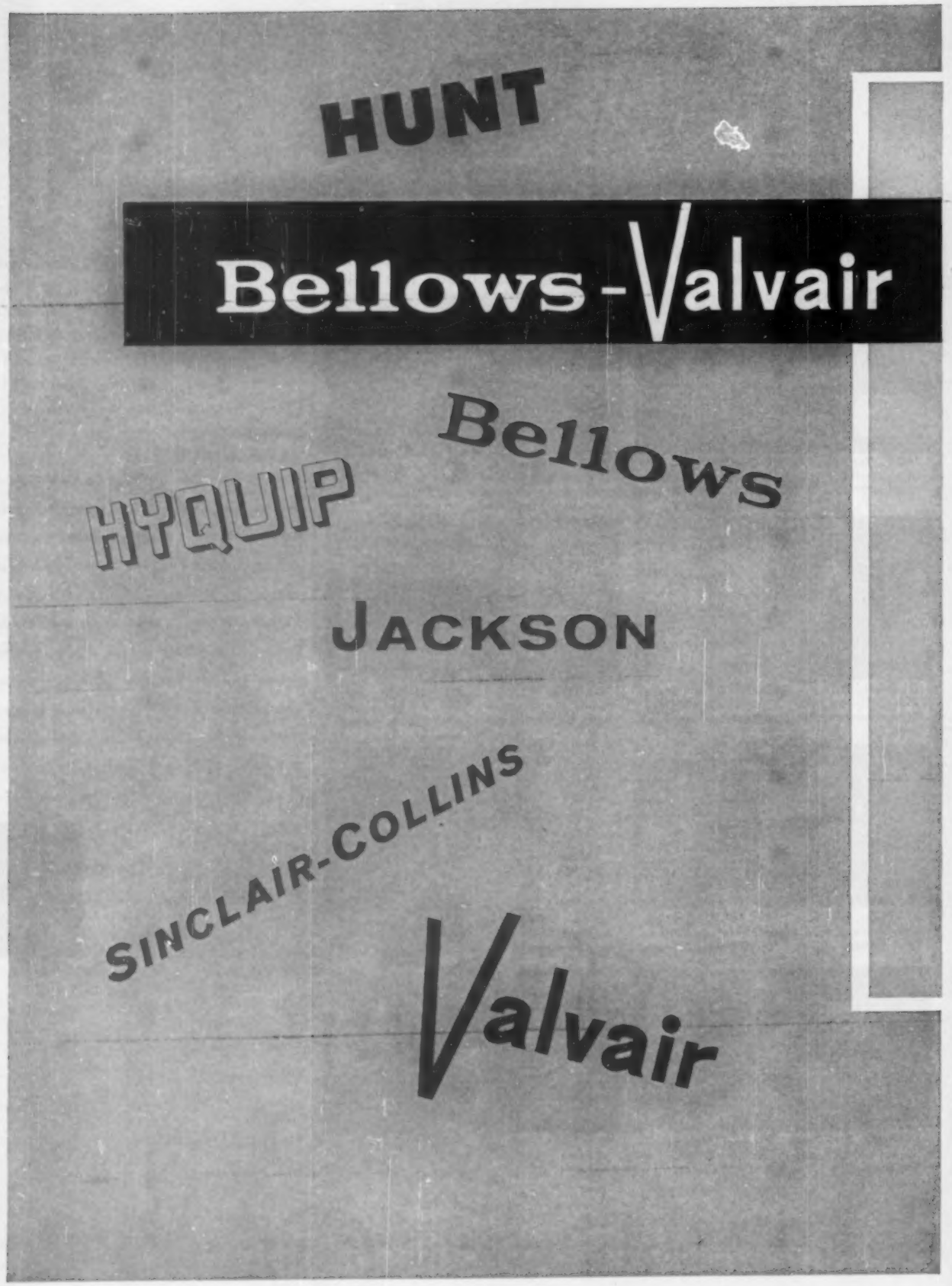
Title_____

Company_____

Address_____

City_____

Zone_____ State_____


HUNT
Bellows-Valvair
HYQUIP
Bellows
JACKSON
SINCLAIR-COLLINS
Valvair

NOW...ONE SOURCE

for pneumatics • hydraulics and related electronics

These famous trade names — Bellows . . . Valvair . . . Hunt . . . Sinclair-Collins . . . Hyquip . . . Jackson — have many things in common. Two are outstanding. These companies are known to industry as leading suppliers of pneumatic, hydraulic and electronic products. And, they all are part of International Basic Economy Corporation (IBEC).

To make it easier for you to select the most economical combination of related products best suited to your needs . . . to provide you with application engineering recommendations for entire control systems . . . to render unmatched service . . . these sources of specialized products have been combined into one engineering, sales and service organization — Bellows-Valvair.

The Bellows-Valvair Pneumatics Division will engineer, sell and service all Bellows, Valvair and Hunt products involving the use of air. The Bellows-Valvair Hydraulics Division will engineer, sell and service Hunt, Sinclair-Collins and Hyquip hydraulic products, as well as Berry-Dowty gear pumps and motors. The Bellows-Valvair Electronics Division will engineer, sell and service all related electronic devices.

Consolidation of all sales and service under the name Bellows-Valvair combines the knowledge and experience of over 300 design, production and field engineers. The resources of this group are at your service, ready to aid you in the engineering and application of pneumatics, hydraulics and electronics, to solve your production problems.

1194-C

New Bulletin FP-62 will give you more information on the divisional product groupings. For your copy, contact the field office near you (listed in the Yellow Pages and Thomas' Register, Volume IV), or write to Bellows-Valvair, Akron 9, Ohio, Dept. MD-1161.

Bellows-Valvair
Division of IBEC ▼ AKRON 9, OHIO

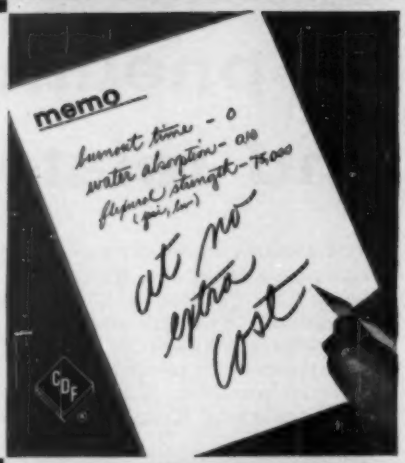
These names assure you the best in pneumatic, hydraulic and electronic components
BELLOWS • VALVAIR • SINCLAIR-COLLINS • HUNT • HYQUIP • JACKSON ELECTRONICS

New Copper-Clad *Reliability*

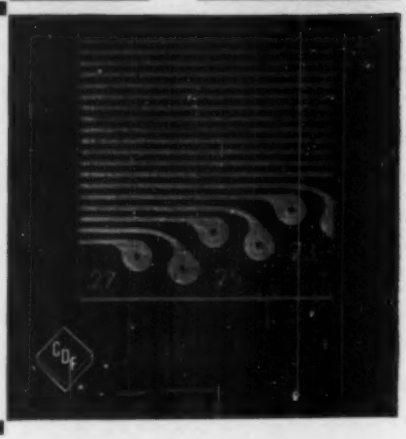
In March, 1961, CDF Grade 614, glass-epoxy laminate, was announced . . . and met with almost overnight acceptance. Particular electronics and electrical manufacturers wasted no time in specifying this premium performance material with zero burnout and minimum "haloing."



By June, 1961, CDF Grade 614 had become the new standard of comparison for applications in critical ground and air-borne circuitry. Designers like its specifications, production men like the way it handles, management likes its reasonable price.



Now, CDF Grade 614 Copper-Clad is setting a new pace among particular producers of printed circuits . . . offering a new high in reliability for high packaging densities . . . and offering researchers a new tool in the investigation of molecular and submicro-circuitry.

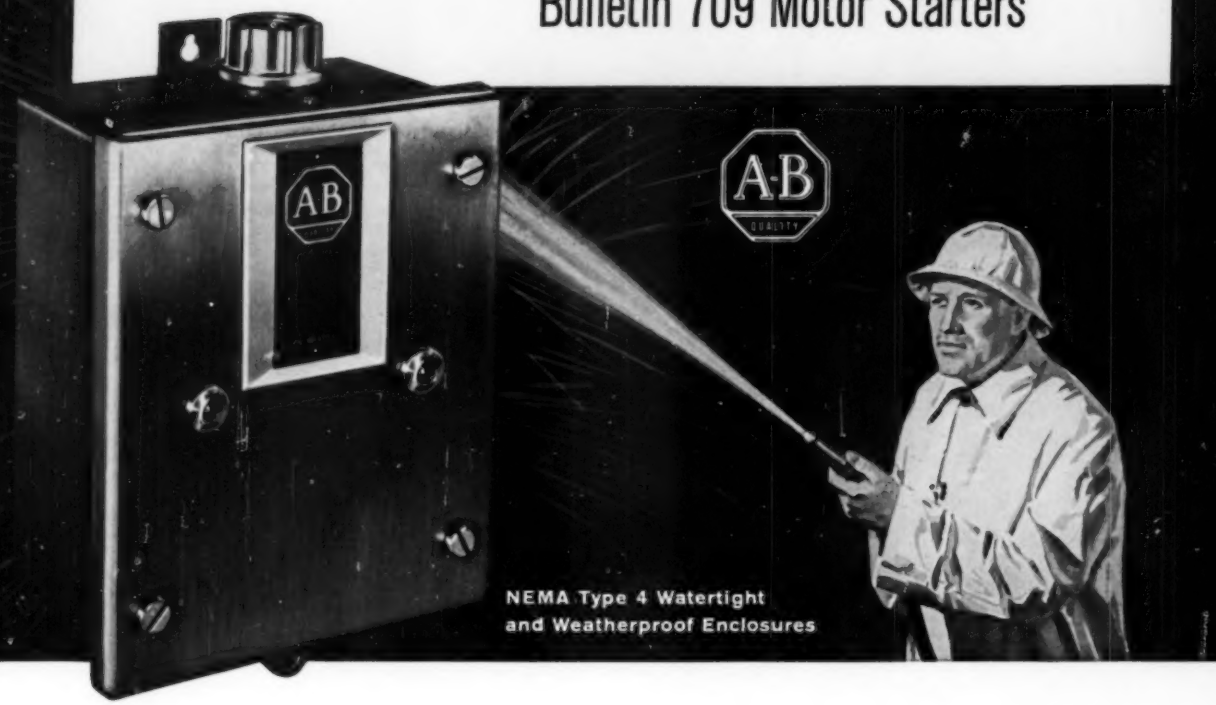


You can take advantage of 614 Copper-Clad's unique features right now . . . in research, development or production operations. Continental-Diamond Fibre Corporation, Newark, Delaware. A Subsidiary of the *Budd* Company.

Please direct inquiries to advertiser, mentioning MACHINE DESIGN

Circle 229 on Page 19→

Allen-Bradley Nema Type 4
STAINLESS STEEL ENCLOSURES for New
Bulletin 709 Motor Starters

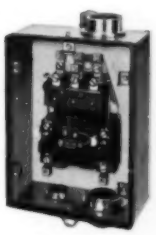


NEMA Type 4 Watertight
and Weatherproof Enclosures

Complete Protection Against Water and Weather!

Allen-Bradley's revolutionary, new line of Bulletin 709 motor starters, which includes reversing switches, multi-speed starters, combination starters, etc., is now available in stainless steel enclosures. Thus the benefits of reduced size, increased interrupting capacity, increased life, and longer trouble free operation can be given to all outdoor installations, or where a great deal of moisture is present. Designed for installation in dairies, breweries, meat and food processing plants and similar locations where a daily "wash-up" is required, the "eye appeal" of these stainless steel enclosures will also be an asset.

The standard Nema 4 enclosures are made of heavy gauge Type 302 stainless steel. However, Type 316 stainless steel can be furnished at a correspondingly higher price. There are many other features about these revolutionary starters that will interest you. Therefore, please write for Publication 6100: Allen-Bradley Co., 1316 South Second Street, Milwaukee 4, Wisconsin.



BULLETIN 709 SIZE 2
in watertight, weatherproof Stainless Steel Enclosure—for use where a great deal of moisture is present, such as tanneries, food processing plants, pump houses, dairies, breweries, etc., or in outdoor locations.

21-61-RM

ALLEN-BRADLEY

Member of NEMA

QUALITY MOTOR CONTROL

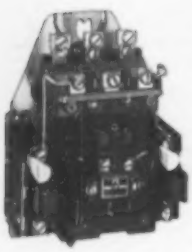
Buy Allen-Bradley Combination Starters— nowhere can you get

AS MUCH FOR YOUR MONEY!



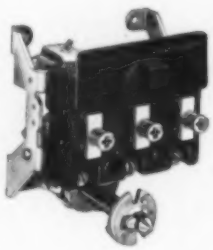
Bulletin 712 Size 1
combination starter with fused disconnect switch in Nema Type 1 enclosure.

The new A-B Series K starter and new A-B disconnect switch in a single enclosure provides complete safety for the operator and the production machine — because the cabinet door cannot be opened until the disconnect is OFF. Also, this "safer" combination starter costs less to install than a separate starter and disconnect switch. There is a neatness about such installations—it is the mark of being up-to-date! Publication 6100 will supply you with complete details—better write for it today: Allen-Bradley Co., 1316 South Second Street, Milwaukee 4, Wisconsin.



A Starter Design Based on 30 Years of Field Experience

The new Series K starters have been completely redesigned for many *more millions* of trouble-free operations. The new magnet is cushioned to reduce wear. The new molded coil is protected against all harmful atmospheres. The new weld-resistant contacts close without wear-causing sliding motion.



Visible Contact Disconnect Switch

When the front-operated disconnect switch is in the OPEN position, all three contacts are clearly visible as being open. An easily removable insulating guard prevents accidental contact with the incoming lines. The double-break, silver alloy contacts operate with positive snap action.



Safety Cover Latching

The door of the enclosure can be opened *only* when the disconnect switch is in the OPEN position. However, it may be opened by *authorized* personnel while the disconnect is closed by means of a hidden defeater screw. Incidentally, this defeater can be made inoperative.



Extra Safety Padlocking

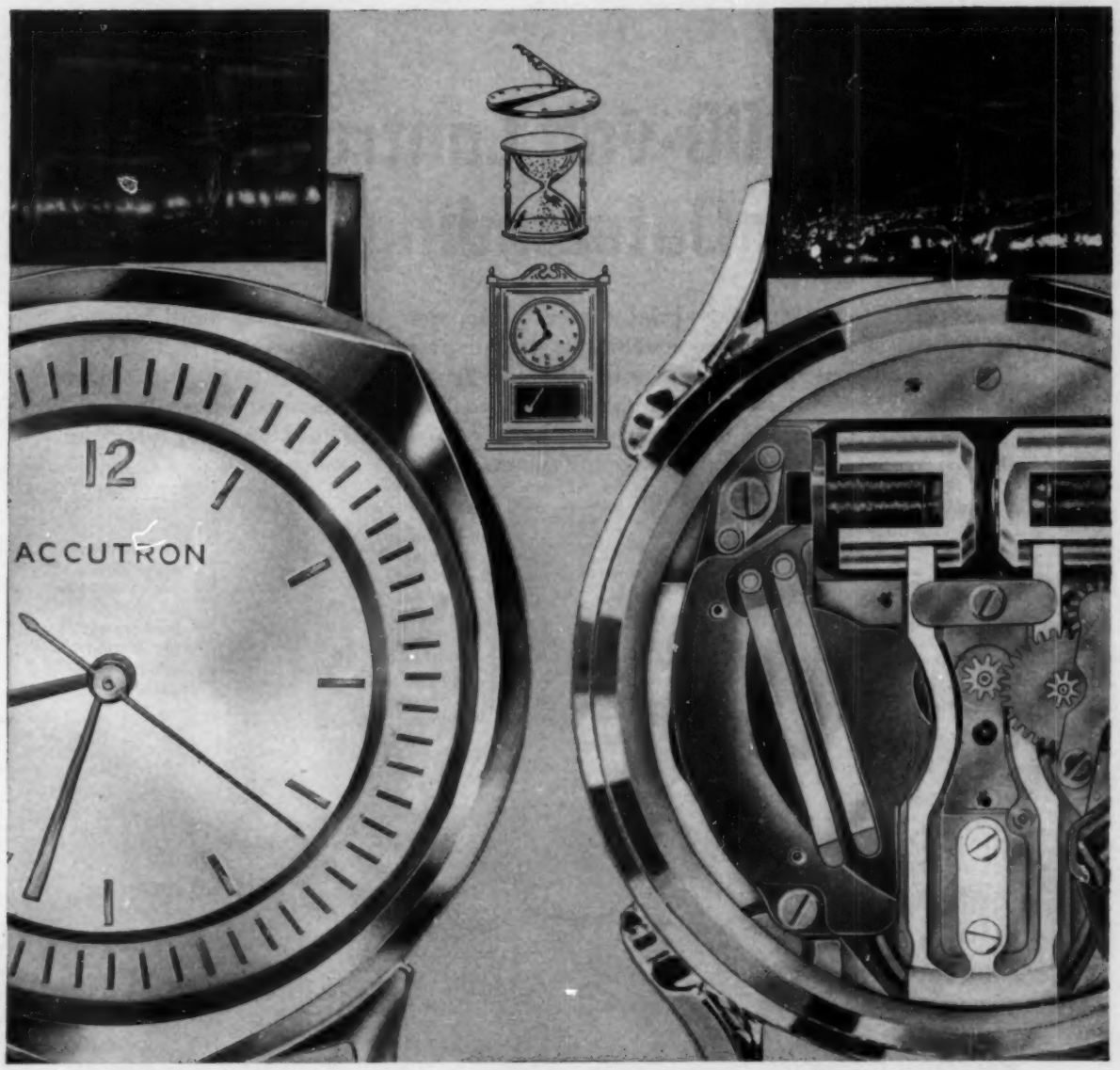
The operating handle can be locked in the OFF position with as many as three padlocks. When desired, means to lock the disconnect switch lever in the ON position can be provided. In addition, the enclosure door can be padlocked closed, with the handle free to be operated.

Can also be supplied as Bulletin 713 combination starter with circuit breakers

21-61-RM

ALLEN-BRADLEY
Member of NEMA

QUALITY
MOTOR CONTROL



How Nickel helps make timekeeping history

Electronic tuning fork made of a Nickel alloy represents the most basic advance in personal timekeeping in 300 years

A watch you don't need to wind. A watch without mainspring, balance wheel, or hairspring. A watch that doesn't gain or lose more than 2 seconds out of every 86,400!

The secret of the fantastic timekeeping accuracy of Accutron* is a precision tuning fork that vibrates more than 31 million times every twenty-four hours—day after day, week after week, month after month...powered by a button-size battery.

To assure the faultless, electronic measurement of time, the tuning fork's incessant vibration must remain constant under a wide range of temperatures and all sorts of shock and impact that can occur in day-to-day watch wear.

That's why electronic engineers chose Ni-Span-C† alloy (42% Nickel) for the heart of this space-age marvel. This high Nickel alloy maintains the fork's vital stiffness at temperatures from 0° to 150° F...fights off damaging corrosion and oxidation.

Just as Nickel helps give this watch's mechanism exceptional reliability, so too Nickel can increase the reliability of hundreds of alloys under many severe conditions—great heat, cold, corrosion, or stress. Alone, or with other elements, Nickel gives alloys the combination of properties to meet the most demanding metals needs.

Perhaps Nickel or a Nickel alloy can help solve your metal problem. To find out, just write to Inco.

*Bulova Watch Company, Inc. trademark.
†Registered trademark, Inco.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street INCO New York 5, N. Y.

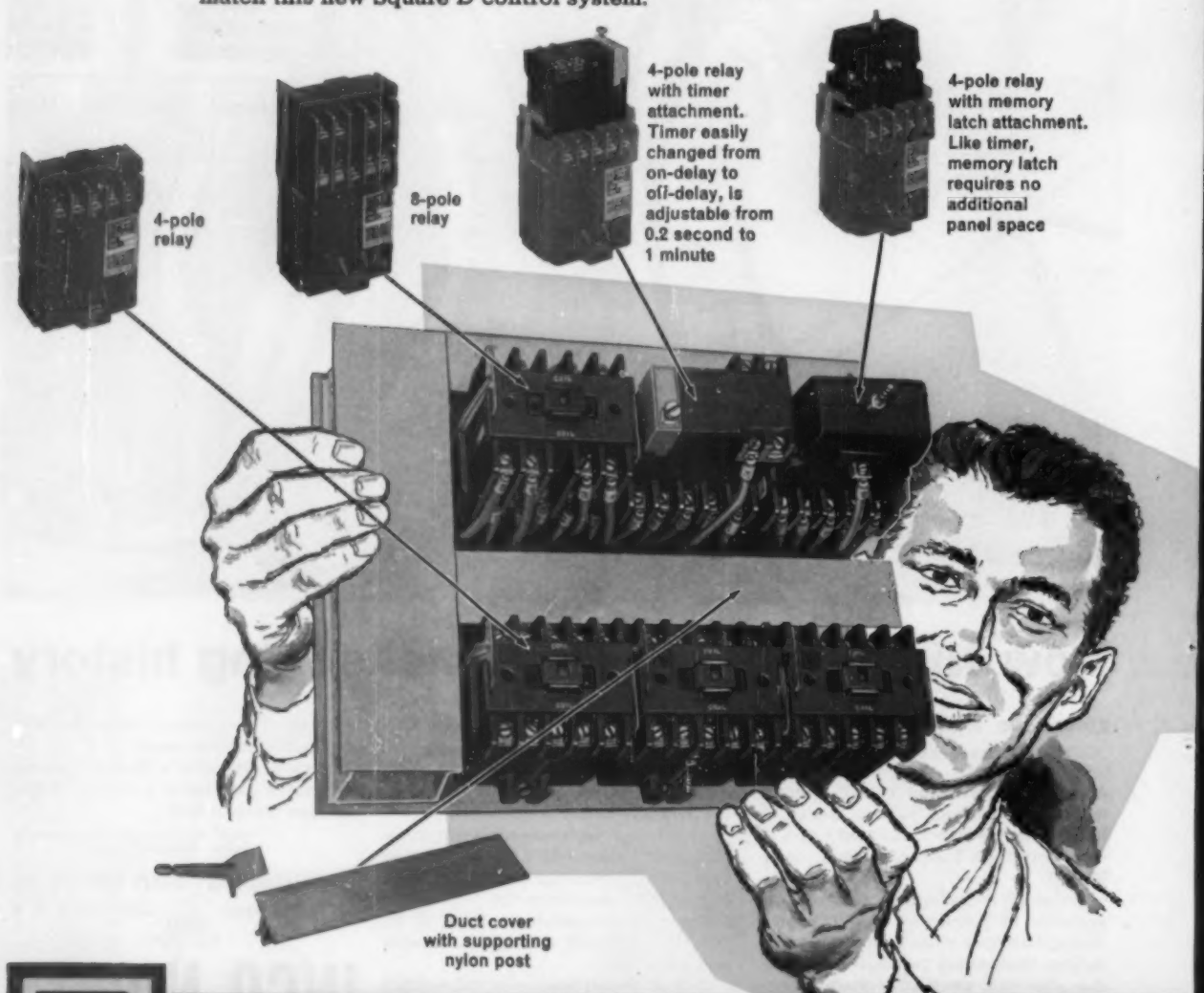
INCO NICKEL

MAKES ALLOYS PERFORM BETTER LONGER

←Circle 229 on page 19

NEW
Square D 300-volt Control System for Outstanding Versatility,

Here's the most advanced, easiest-to-use control system ever built! Just two basic relays plus two attachments (latching mechanism and timer) fill all your requirements. Square D's new 10-ampere **Type G relay** is small—has convertible contacts—can be disassembled in seconds without removing wiring—is manually operable—makes its own duct. Feature for feature, no other relay can match this new Square D control system.

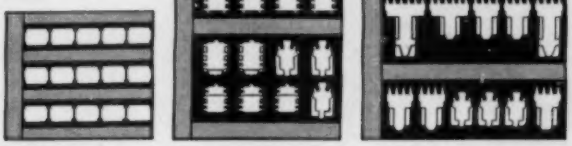


SQUARE D COMPANY

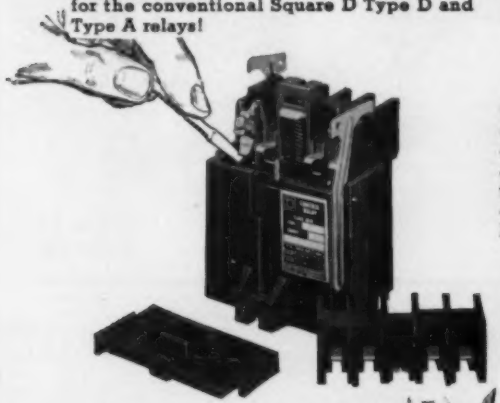
Drastically Reduced Panel Space!

NEW DESIGN MEANS BIG SPACE SAVINGS

Relays can butt together, save panel space through both small size and reduced wiring area. Each of these three panels provides 11 relay functions, 3 timing functions and 2 memory functions. Each is built with proper spacing for devices and wiring. Yet compare the size of the panel built with new Type G systems relays with the panel space required for the conventional Square D Type D and Type A relays!



Type G relays | Type D relays | Type A relays



Convert contacts from normally open to normally closed (or vice versa) without removing a screw, without adding a single part, without touching the stationary contacts or removing any wiring. Just flip over the movable contact with a screwdriver. All contacts double-break, individually convertible for any combination you need.





Easy-to-wire terminals are out in the open, even with the duct cover installed. Coil terminals are on the same level for quick accessibility. Pressure wire connectors are standard, with slip-on connectors also available.

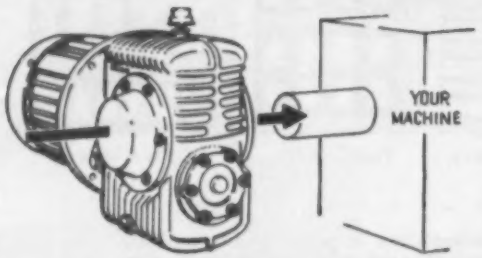
Fast disassembly—Just lift up and slide back the latches and disassemble in seconds for quick coil change, contact conversion or inspection. No screws to remove, no special tools needed. Wiring stays undisturbed throughout.

Manually operable and also gives visual indication of operation

Get All the Facts! Send for Bulletin SM-307 with dimensions, ordering information—the complete story on the new Square D 300-volt control system. Square D Company, Dept. SA, 4041 North Richards Street, Milwaukee 12, Wisconsin.

wherever electricity is distributed and controlled

CONE-DRIVE GEARMOTORS for "PLUG-IN" POWER

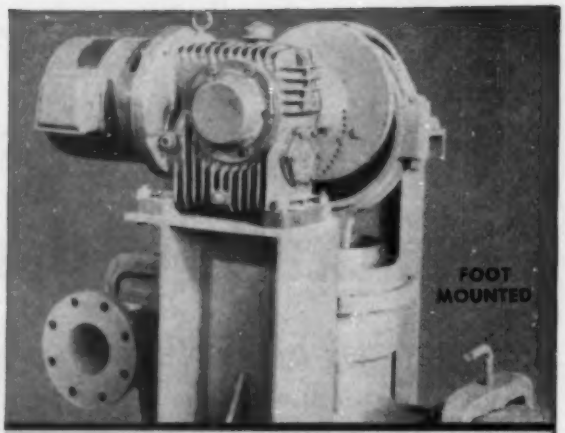


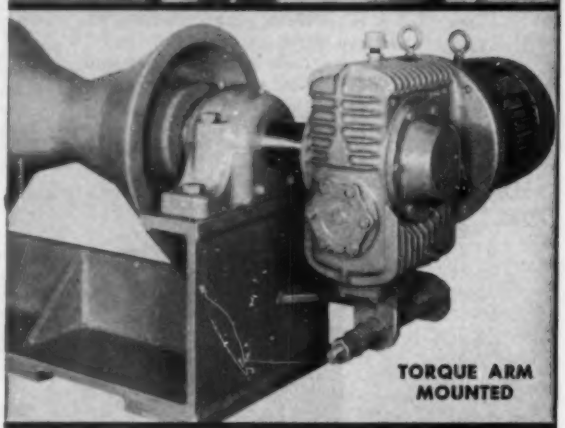
Hollow-Shaft Speed Reducer-Motor forms complete power transmission package . . .

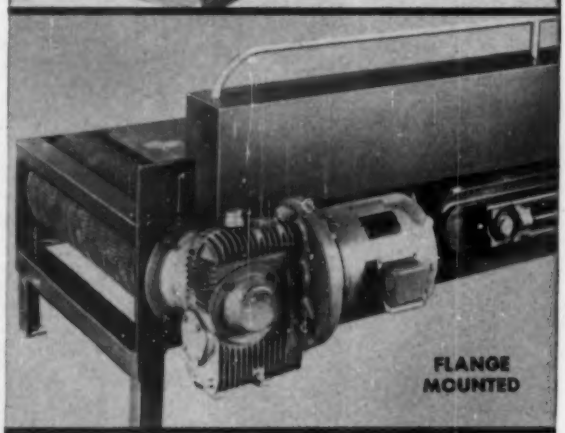
With the compact, right-angle Cone-Drive gearmotor the machine designer can make use of an integral drive package of nearly any required speed and horsepower. Twenty-seven standard output speeds from 7.3 to 525 RPM (with 1750 RPM motor) are available in models from ¼ to 40 horsepower. Gearmotors can be specified with hollow shaft for mounting in any position, ready to "plug-in". You can use this integrated power package to provide a simple, clean installation on your machine . . . no pulleys, belts, sheaves, bed plates, couplings, etc.

Electric motors are standard "D" flange type with slight shaft modification for driving helical primary reduction gears. Secondary reduction stage is a standard Cone-Drive double-enveloping worm gearset with maximum tooth engagement for greater load carrying capacity in smaller space.

Cone-Drive gearmotors are available for all AGMA service ratings. Call your Cone-Drive representative today or write for catalog #58 for complete specifications.









CONE-DRIVE GEARS
DIVISION MICHIGAN TOOL COMPANY
7171 E. McNichols Road Detroit 12, Michigan Telephone: TWinbrook 1-3111

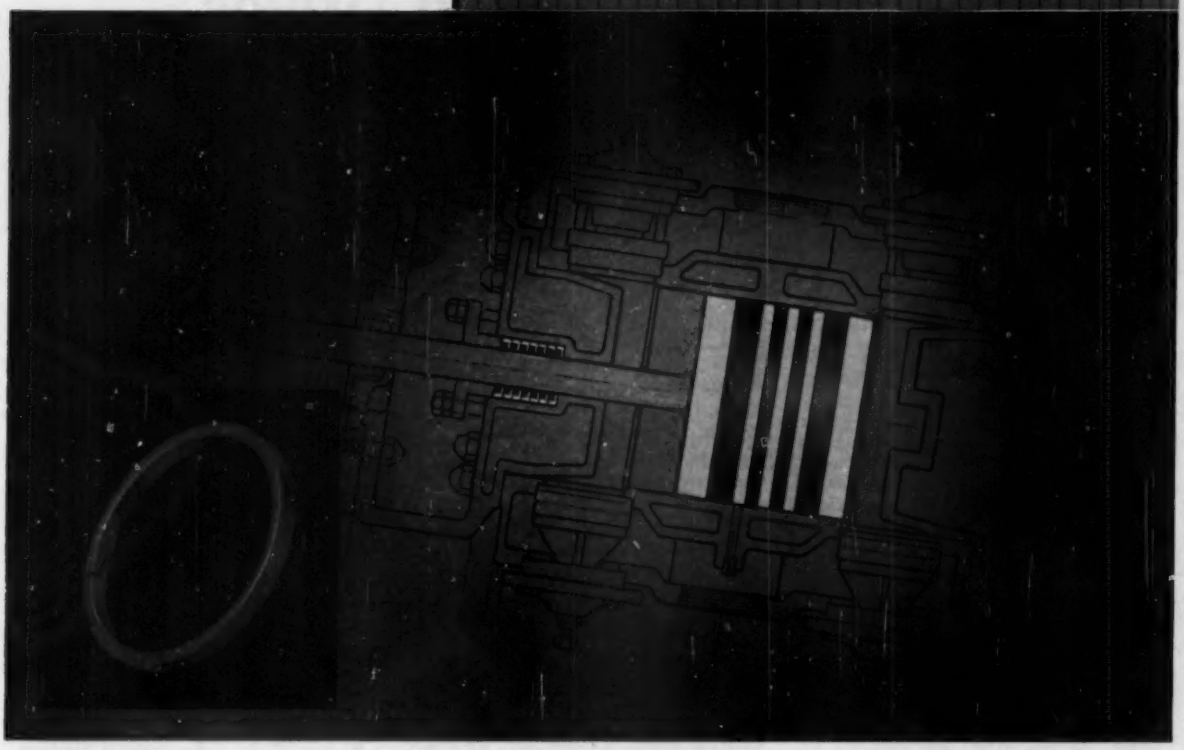

DOUBLE-ENVELOPING WORM GEARSETS


DOUBLE-ENVELOPING WORM GEAR SPEED REDUCERS


DOUBLE REDUCTION WORM GEAR SPEED REDUCERS


DOUBLE-ENVELOPING RIGHT ANGLE GEARMOTORS

DU PONT TEFLON®



How piston rings of TEFLON® saved $1,600 per year in compressor maintenance alone

CAN YOU AFFORD NOT TO USE TEFLON?

- Piston rings of TEFLON are your most economical choice whenever product contamination is a problem . . . whenever maintenance costs should be cut . . . whenever lubrication should be reduced or eliminated.
- Rings of TEFLON can permit bone-dry operation . . . provide more uniform output because there is less gas blow-by . . . reduce danger of fretting, galling and cylinder wear.
- Rings of TEFLON are not brittle . . . resist chipping, cracking, breaking . . . installation, storage and handling are easier.
- Rings of TEFLON make possible substantial savings in operating, maintenance and replacement costs.

In a plant manufacturing chemical intermediates, a two-stage compressor handled ethyl chloride. In this service, standard carbon piston rings required constant lubrication and maintenance during their average life of 2,000 hours. Conversion of this unit to piston rings of a TEFLON TFE resin had dramatic results. These rings operated for 10,000 hours without maintenance. Lubrication and product contamination were eliminated. On this one compressor, the plant saved $1,600 in maintenance costs alone.

Such savings and improvements are typical of those provided by rings of TEFLON. If you are buying a new compressor, specify rings and packings of TEFLON. To convert your present equipment, check with your compressor manufacturer or qualified ring supplier for engineering and design assistance. For further information, write: E. I. du Pont de Nemours & Co. (Inc.), Dept. MD-11-T, Room 2526, Wilmington 98, Del. *In Canada*: Du Pont of Canada Limited, Box 660, Montreal, Que.

DU PONT REG. U.S. PAT. OFF. **TEFLON®** FLUOROCARBON RESINS

TEFLON is Du Pont's registered trademark for its family of fluorocarbon resins, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resins.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

[Advertisement]

Control your speed with Century's complete line of Selective Speed Drives

We're often asked why Century offers six different basic types of selective speed drives. The answer is simple—what is ideal for one type of application may be completely unsuitable for another. No one, two, or three lines—no matter how complete each of them is—can match every application that requires easily adjustable speed. That's why Century offers the most complete lines available to industry.

But with several separate and distinct lines, the choice of which type to use for a particular application sometimes appears complicated. To take some of the mystery out of controlled speed drive selection, we've described the six various types we manufacture below. See which one fits your needs best:



Mechanical Selective Speed Drives

Type:
Constant-torque variable horsepower

Horsepower range:
½ Hp to 30 Hp

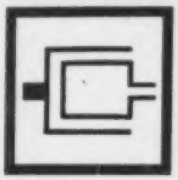
Speed ranges:
2:1, 3:1, 4:1, 5:1, 6:1, 8:1

The Century type MD Drive is simple, inexpensive and compact, and can be controlled either manually or automatically. It utilizes a standard Century motor, a variable pitch belt drive transmission, and a gear reduction unit when low speeds are required. Other than standard squirrel cage, normal torque motors can be furnished where required.

Type MD units incorporate a Century-designed cooling system that extends belt life and permits increased load factors. Drive and driven pulleys are constantly aligned to automatically correct belt tension. Design simplicity is such that modifications can easily be made in the field, such as changing from "horizontal" to "upright" mounting, moving the control to different positions, or changing drive motors.

The standard unit has an easy-operating handwheel with built-in indicator for speed control. Mechanical, electric remote and pneumatic control can also be easily adapted.

Typical mechanical drive applications are packaging and labeling machines, conveyors, pumps, agitators, textile machines, plastic extruders, testing equipment, canning machines, printing presses, etc.



Magnetic Coupling Selective Speed Drives

Type:
Constant- or variable-torque

Horsepower:
Constant-torque 1 through 500 Hp; variable-torque 1 through 1000 Hp

Speed ranges:
8:1 standard

The type MC Century magnetic coupling drive consists basically of a squirrel-cage induction motor and a magnetic coupling connected to the output shaft. There is no mechanical connection between the driving and driven members of the unit; torque is transmitted by magnetic flux. Output speed is controlled by regulating the excitation to the magnet member of the clutch.

Several reasons have contributed to the increasing use of magnetic coupling drives:

1. They have a lower initial cost.
2. All-electric, they are easy to maintain. Circuits can be understood and serviced by any competent plant electrician.
3. Space requirements for these drives are at a minimum.
4. Speed regulation is excellent, due to tachometer feedback control. Plus or minus 2% maximum speed regulation with load changes from 25% to 100% full load is standard.

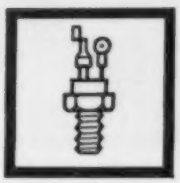
Constant-torque MC drives have several definite minimum operating speeds listed for continuous duty. With variable-torque units, there is no minimum operating speed due to nature of loading. Drives may be equipped to operate at inching or jogging speeds for setup purposes, or at very low speeds on an intermittent basis. Control may also be manual or automatic, as a function of temperature, pressure flow, or almost any other controlling factor.

Three types of Century Magnetic Coupling Drives are built:

Form A Drives are constructed with the AC drive motor and magnetic coupling as an integral unit. They can be mounted with the drive shaft either horizontal or vertical. Typical uses for these units are for such constant-torque loads as conveyors, slitters, printing presses, coaters, laminators, etc.; and variable-torque loads of centrifugal pumps, fans and compressors.

Form B Drives have the AC drive motor and magnetic coupling assembled on a common bedplate and are furnished as a complete unit. Applications of this unit for constant-torque or variable-torque loads are similar to the Form A unit.

Form C Drives are furnished as separate units, with AC drive motor and magnetic coupling furnished as individual units for final coupling or belting by the customer to suit specific job needs.



Controlled Rectifier Selective Speed Drives

Type output:
Constant-torque

Horsepower:
Half-wave—1/12 to 1 Hp
Full-wave—1/12 to 15 Hp

Speed ranges:
75:1 standard

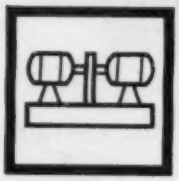
These units utilize silicon-controlled rectifiers with special patented triggering circuits. They are completely static and eliminate use of electronic tubes. Each complete set consists of a packaged static type power unit; DC drive motor, and an operator's station. Drive motors may be furnished with almost any mechanical modifications.

Some of the outstanding advantages of controlled rectifier drives are these:

1. No warm-up time is required before starting up.
2. Tube flashover and arcing is eliminated.
3. There are no relays to service.
4. Speed regulation is close.
5. The improved wave-form factor resulting from the use of silicon rectifiers permits the use of a smaller drive motor than equivalent electronic drives.

6. Complete short circuit and overload protection is provided.
7. In many cases, mechanical modifications are less expensive than with equivalent electronic drives.

Typical applications of Century type CRF and CRH controlled rectifier drives include: blue print machines, conveyors, printing presses, welding positioners, etc.



Motor-Generator Set Selective Speed Drives

Type output:
Constant-torque, minimum to base speed; constant-horsepower above base speed.

Horsepower range:
1 through 500 Hp

Speed ranges:
Almost any required ranges available.

Century type MGE and MGM Motor-Generator Sets are packaged selective speed drives that provide all the versatility of direct current adjustable voltage systems. Advantages of these units include wide speed range for continuous operation, exact speed control under any loading condition, and either single or multi-motor drives.

Complete unit consists of a packaged-type power unit with power-conversion equipment and controls; a DC adjustable drive motor, and operator's control station. Drive motors may be furnished in any desired enclosure or with almost any mechanical modifications.

Typical applications for Century type MGE and MGM Motor-Generator Sets include: paper rewinders, paper slitters, steel slitters, tube mills, brick presses, plastic extruders, textile ranges, wallboard applications, etc.



Electronic Type Selective Speed Drives

Type output:
Constant-torque

Horsepower ranges:
1/20 to 30 Hp

Speed ranges:
Up to 100:1

Three types of Century Electronic Drives are available. Type TH is a half-wave rectifier unit, designed for lower horsepower ranges, 1/20 to ¾ Hp. Type TF, full-wave rectification, is intended for applications from ¾ to 4 Hp. Type TA, also full-wave rectification, is built in sizes from ¾ to 30 Hp.

Type TH Electronic Drives provide the following advantages in lower horsepower ranges:

1. Wide speed range. (20:1 standard, 50:1 available)
2. Close speed regulation—±3% of base speed maximum.
3. Reasonable initial cost.
4. Simplified maintenance.
5. Stepless speed control over the unit's entire range.
6. Extremely smooth acceleration.
7. Dynamic braking available.
8. Operating speed can be preset.

Typical applications for Type TH Electronic Drives include: packaging machinery, small printing presses, conveyors, machine tool feeds, trimming machines, etc.

Type TF bridge-type adjustable voltage electronic drives provide operation over a wide speed range (8:1 standard; as high as 100:1 available for light loads and intermittent duty) at the same time it furnishes close speed regulation (plus or minus 3% of base speed).

Smooth acceleration is one of the important advantages of this equipment. This protects the connected machinery and work-in-process from shocks and damage due to rapid acceleration. Tube circuits are designed to "fail safe," eliminating the danger of motor runaways in the event of failure.

Typical uses for Type TF drives include: paper machines, machine tools, textile machines, small conveyors, bagging machines, and other applications where good speed regulation over a wide range is important.

Type TA Electronic Speed Drives are ideal for applications that require extremely wide speed range with close speed regulation. Standard factory adjustment is for a 50:1 speed range. 100:1 may be furnished for special intermittent applications.

Speed regulation can be set "flat" for any speed and when this is done, regulation for any other speed will be within 2% of base speed, with 80% load change, and within 1 to 2% of base speed with line voltage fluctuation of plus or minus 10%.

Since acceleration is under constant current, smooth start-up is inherent in the drive. Starting current may be easily adjusted from 50% to 200% of full-load current.

Dynamic braking is standard. Dynamic slow-down and reversing can also be supplied as options.

Type TA Drives find wide use driving machine tools, processing equipment, conveyor lines, precision welding positioners, etc.



Magnetic Amplifier Selective Speed Drives

Type output:
Constant-torque

Horsepower range:
1 through 200 Hp

Speed range:
8:1

Century Type SA Magnetic Amplifier drives replace electron tubes and circuits with power magnetic amplifiers and static silicon rectifiers for trouble-free and maintenance-free operation. The unit is packaged and completely prewired.

Some of the important advantages of these units are as follows:

1. 5% speed regulation from 20% to 100% load.
2. Complete overload and rectifier protection.
3. Timed acceleration (2-30 Hp) and current limit acceleration (40-200 Hp) prevents electrical or mechanical overloads when changing speeds.

These drives are highly useful in applications where speed regulation is not extremely critical, such as: printers slotters, printing presses, plastic extruders, etc.

In a host of industries, Century Selective Speed Drives have improved quality, increased production, reduced scrap and waste, lowered maintenance costs, made production schedules more flexible, cut downtime and unit costs, or created other benefits. And there's a good chance that they can improve *your* product or process.

Want to know more? Century has prepared a new 246-page Controlled Speed Catalog with specifications, prices, modifications and dimensions on all six basic types of Century Selective Speed Drives. We'll send you a copy if you'll request it on your letterhead. Or call your nearby Century Sales Engineer for recommendations on the drive that's just right for *your* job. 61-1

CENTURY ELECTRIC COMPANY

St. Louis 66, Missouri *Offices and Stock Points in Principal Cities*

Circle 233 on Page 19

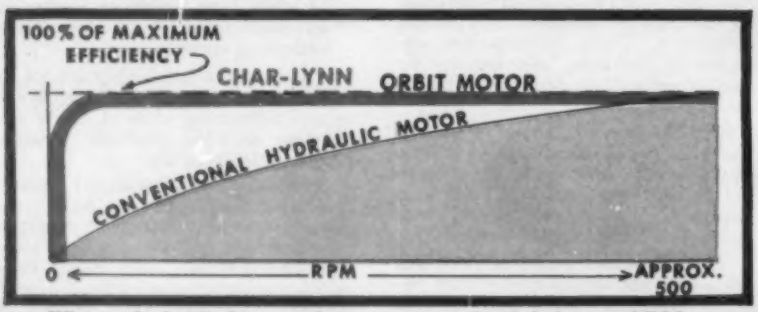
HIGH TORQUE at SLOW SPEED



New Char-Lynn Hydraulic ORBIT MOTORS® deliver Full Torque regardless of speed range

It's Here—A NEW concept in fluid power mechanics has brought about the development of a totally new fluid motor—A *High Torque—Low Speed* motor.

These motors open up complete new areas for design, never before possible. They offer a practical and economical hydraulic solution to the age-old problem of providing High Torque at Low Speeds for constant and variable speed drives—hydrostatic transmissions and remote controls *without* bulky, costly mechanical drives and gear reducers.



Whereas hydraulic losses make some conventional designs prohibitive at the lower speeds, Char-Lynn ORBIT MOTORS maintain high efficiency over the complete operational range.

- Speeds from 0—800 RPM
- Torques to 3300 inch lbs.
- Starting torque substantially equal to running torque
- Fully reversible — instantaneous starting—stopping
- Only 3 moving parts
- 4 types of mountings available
- 3 port sizes—7 power element selections
- Compact—lightweight
- Eliminates costly and complicated power transmissions
- High volumetric and overall efficiency

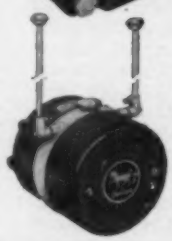
Complete your HYDRAULIC CIRCUITS with Char-Lynn COMPONENTS



HOLDKONTROL VALVE V-960



HORSEPOWER PUMP 400



HI-LO POWER PAC PUMP P-600



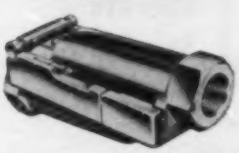
STROKONTROL CYLINDER C-133



HORSEPOWER CYLINDER C-102



HYDRAULIC FLUID FILTER F-240

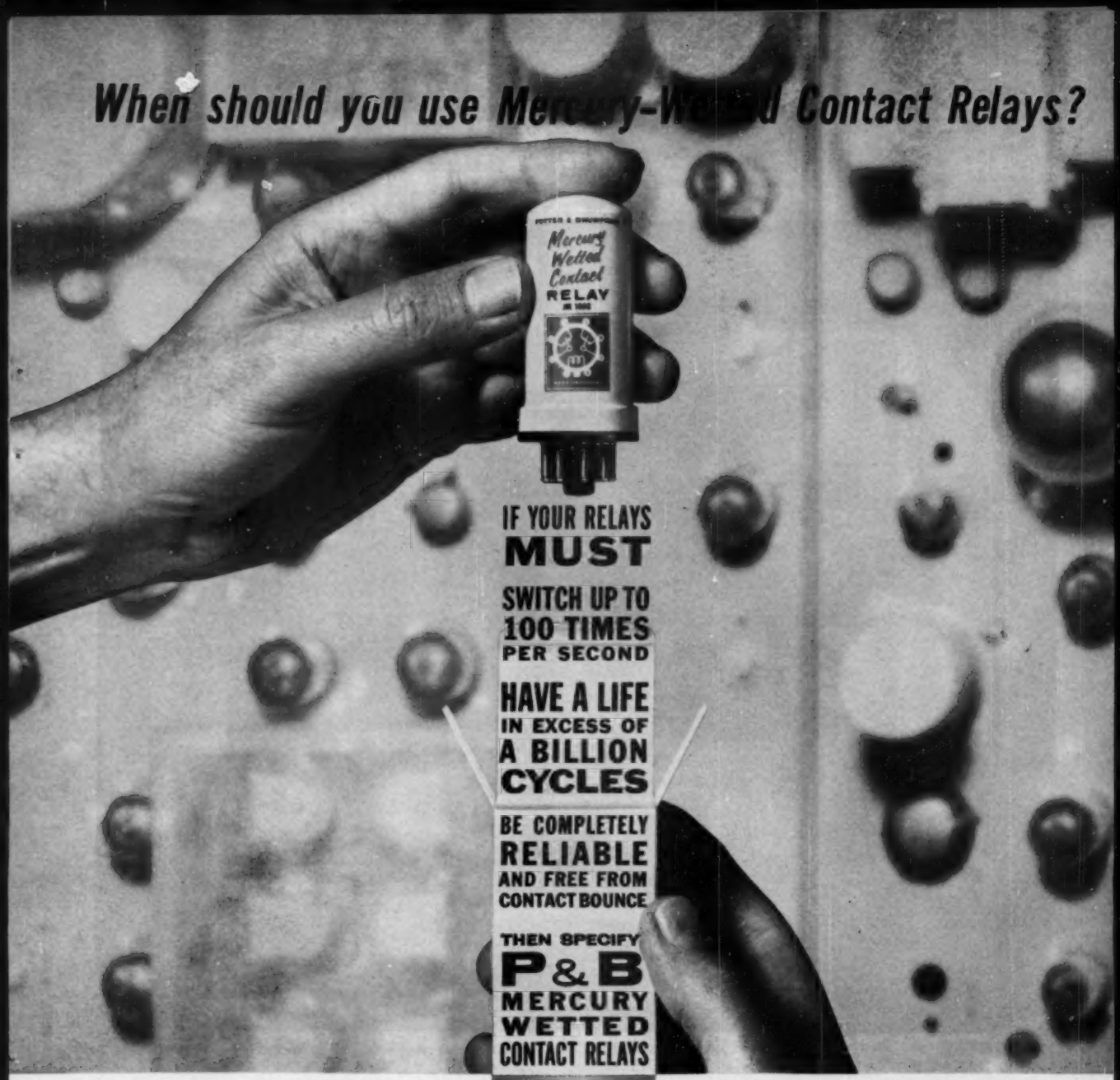


HOSE COUPLER H-730

For complete details write Dept. HM Char-Lynn Company • 2843-26th Avenue South, Minneapolis, Minnesota

HYDRAULIC HORSEPOWER PRODUCTS

When should you use Mercury-Wetted Contact Relays?



IF YOUR RELAYS MUST

SWITCH UP TO 100 TIMES PER SECOND

HAVE A LIFE IN EXCESS OF A BILLION CYCLES

BE COMPLETELY RELIABLE AND FREE FROM CONTACT BOUNCE

THEN SPECIFY P&B MERCURY WETTED CONTACT RELAYS

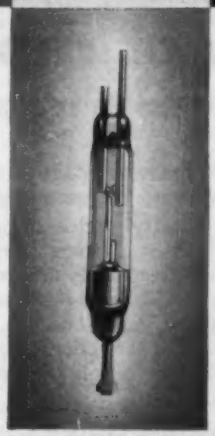
An unusual combination of advantages found only in mercury-wetted relays has led many design engineers to specify them for tough switching jobs. Here are but 3 typical characteristics of our JM series:

RELIABILITY. Sealed-in-glass mercury contacts are renewed with every operation. Won't pit or weld. Make or break is positive . . . every time. No bounce, no chatter. Signals ranging from a few micro amps to 5 amps are switched with singular consistency.

LONG LIFE. Think in terms of *billions* of operations when considering JM series relays. Proper application, of course, is a requisite.

SPEED. Operate time is just less than 3 milliseconds using 2 watts of power. Release time is about 3.2 milliseconds. Thus, relays can be driven 100 times per second.

If your project calls for exceptional relay performance, perhaps the answer lies in our JM Mercury-Wetted contact relay.



JM SERIES ENGINEERING DATA

Contact Rating:
5 amperes maximum
500 volt maximum
250 volt-amp max. with required contact protection.

Contact Configuration:
Each capsule SPDT. Combination of capsules in one enclosure can form DPDT, 3PDT, 4PDT. (All Form D.)

Terminals:
Plug-in or hook solder; 8, 11, 14, or 20-pin headers.

Coil Resistance:
2 to 58,000 ohms.



More information?
Write today for free catalogue.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

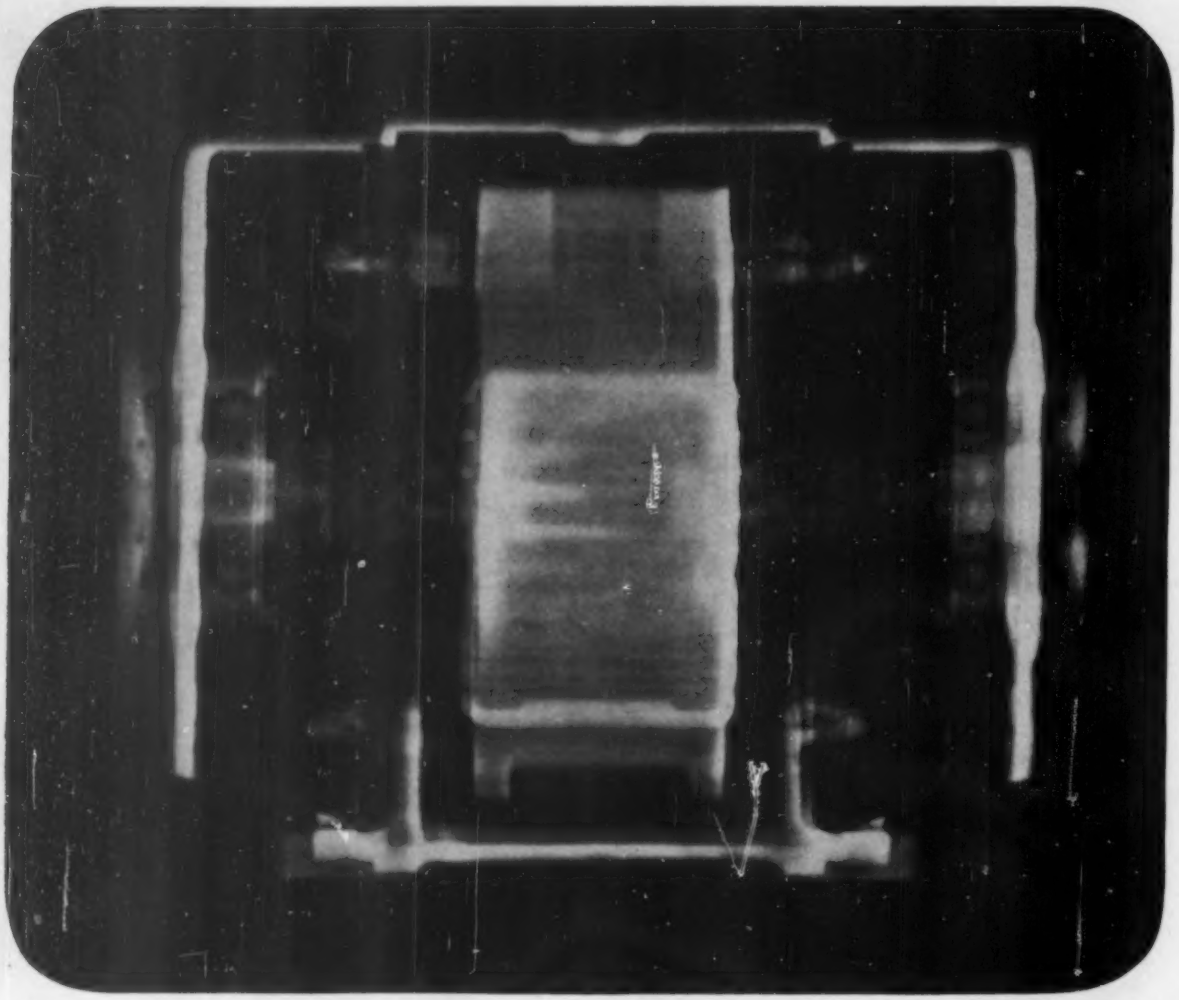
POTTER & BRUMFIELD

DIVISION OF AMERICAN MACHINE & FOUNDRY COMPANY • PRINCETON, INDIANA
IN CANADA: POTTER & BRUMFIELD, DIVISION OF AMF CANADA LIMITED, GUELPH, ONTARIO

Circle 234 on Page 19

ALLIS-CHALMERS

A-1308



Actual radiograph of a 5-hp open-type motor taken with a 24-million volt Allis-Chalmers Betatron.

X-ray view of motor health

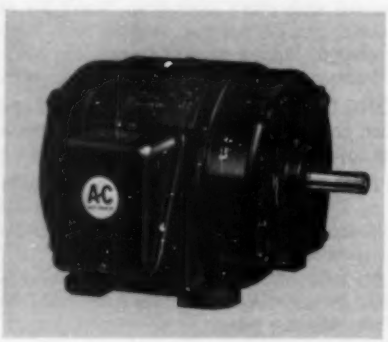
Invisible standards of perfection increase life expectancy of every Allis-Chalmers motor

The exceptionally long performance of A-C open motors proves the value of thinking *beyond* established standards of design . . . of taking "significant new achievement" as the ideal.

This ideal led to many refinements for A-C open motors: double-shielded bearings that keep dirt out and allow controlled migration of grease, permanently numbered leads for easy identification and connection, and heavy-duty cast iron frames that resist corrosion and keep rotating parts perfectly aligned.

For totally-enclosed, open-type and *Super-Seal* general purpose motors, and electrically or mechanically modified definite-purpose motors, choose the motor built to invisible standards of perfection. Choose A-C. Special application help available.

Call your nearby A-C representative. Or write **Allis-Chalmers,** *Industrial Equipment Division, Milwaukee 1, Wis.* Super-Seal is an Allis-Chalmers trademark.



PRODUCT-DESIGN BRIEFS FROM DUREZ

- **Plastic bearing material**
- **Making epoxies retard fire**
- **Phenolic for motor housings**



MICRO-PRECISION DIVISION, MICROMATIC HONE CORPORATION

Outwears metal bearings

Loads as high as 50,000 psi don't bother this plastic bearing.

In severe high-load, low-speed tests, it came through 60 million cycles without failure—while ordinary bearings gave up at 50,000 cycles.

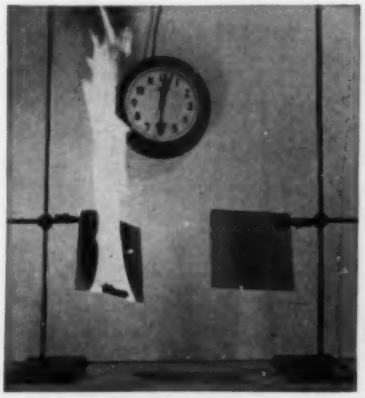
What helps make it so rugged? One fact is the material used on the outside to encase the bearing material. The bearing material may be considered an insert which is molded in place in one operation. The support material is *Durez 16771*, a glass-filled phenolic molding compound.

Besides being strong and tough, *Durez 16771* withstands oil, grease, and acid; can't pit, rust, or corrode.

What can you do with an idea-plastic like this? Automotive designers are putting it to work now in oil-pump gears, automatic transmission parts. Check into the places where a tough, high-impact plastic could do a better job than the material you're using. Then ask your molder for more details on *Durez 16771*—or check the coupon for Bulletin D203, which describes the material and its capabilities.

The hardener does it

Could you be looking for an epoxy that retards fire?



Here are two epoxy laminates we made up in the laboratory. Both were exposed to equal flames for 30 seconds. When the flames were removed, one laminate blazed merrily on. The other snuffed out instantly, with slight local charring.

The only difference in composition was in the hardener or curing agent used: at the left, a conventional one; at the right, our HET® Anhydride.

Besides conferring flame retardance, HET Anhydride gives a liquid epoxy resin a high heat-distortion point and superior flexurals at 350° F. It won't stain hands or cause dermatitis. And it costs less than most hardeners.

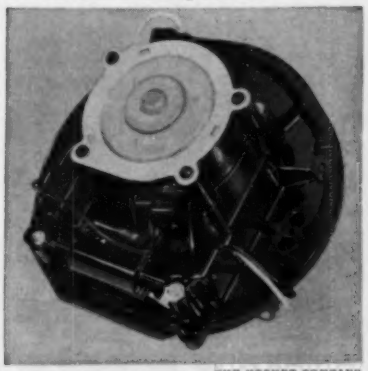
We don't make epoxies, but we'll be glad to send you data on HET Anhydride. Just check the coupon for it.

Housing for life

Here is part of an appliance not built for planned obsolescence.

The new Hoover convertible vacuum cleaner, say its makers, is designed for virtually a lifetime of service. Its engineering represents over 50 years of leadership in a highly competitive field.

It's significant, then, that to enclose the cleaner's two-speed ¼-hp motor, Hoover designers settled on a housing of molded Durez phenolic.



THE HOOVER COMPANY

You needn't look far to find good sound reasons for using phenolic to mount or protect a motor. Phenolic gives lifetime stamina at low cost. It's rugged, non-warping—yet weighs less than other housing materials. On a complex part, it can save you much machining.

Your custom molder can tell you more. Or use the coupon to request fact-crammed Bulletin D400 on Durez molding materials, their properties, and uses.

For more information on Durez products mentioned above, check here:

- ☐ High-impact molding compound *Durez 16771* (Bulletin D203)
- ☐ Epoxy hardener, HET Anhydride (Bulletins 19 and 43)
- ☐ Durez molding materials (descriptive Bulletin D400)

Check, clip and mail to us with your name, title and company address.

DUREZ PLASTICS DIVISION

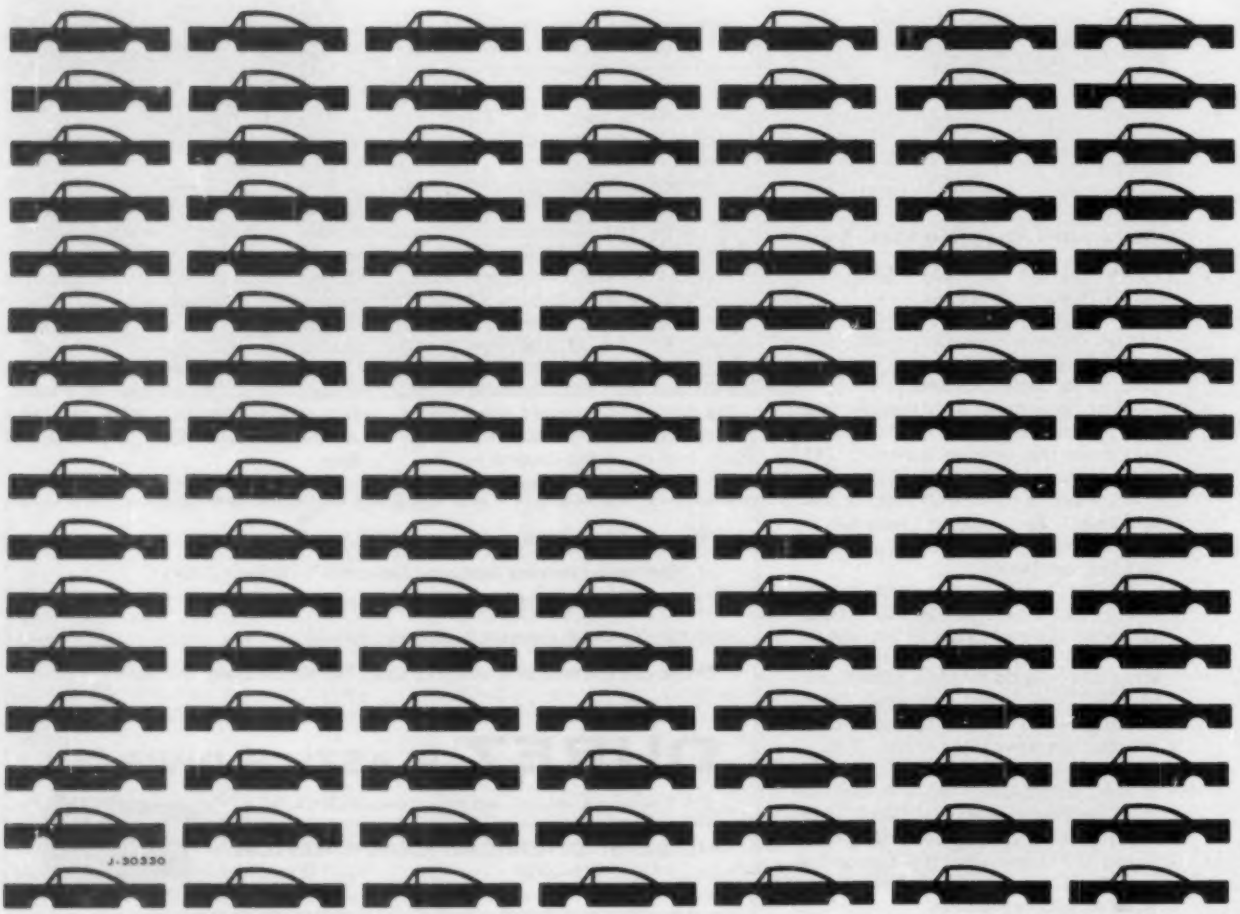
511 WALCK ROAD, NORTH TONAWANDA, N. Y.

HOOKER CHEMICAL CORPORATION

HOOKER CHEMICALS PLASTICS

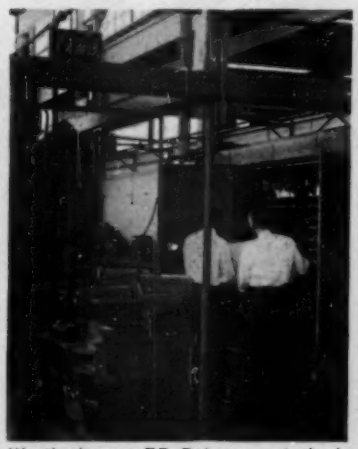
Circle 236 on Page 19

The Westinghouse BF Relay is helping the automotive industry solve its floor space problem. One automotive customer was able to reduce the length of a single control panel from 36 feet to 22 feet. Another eliminated one of three panels. The Westinghouse BF Relay is a new concept in relay design tailored to space-saving needs of automation. As many as four BF Relays fit in the space of



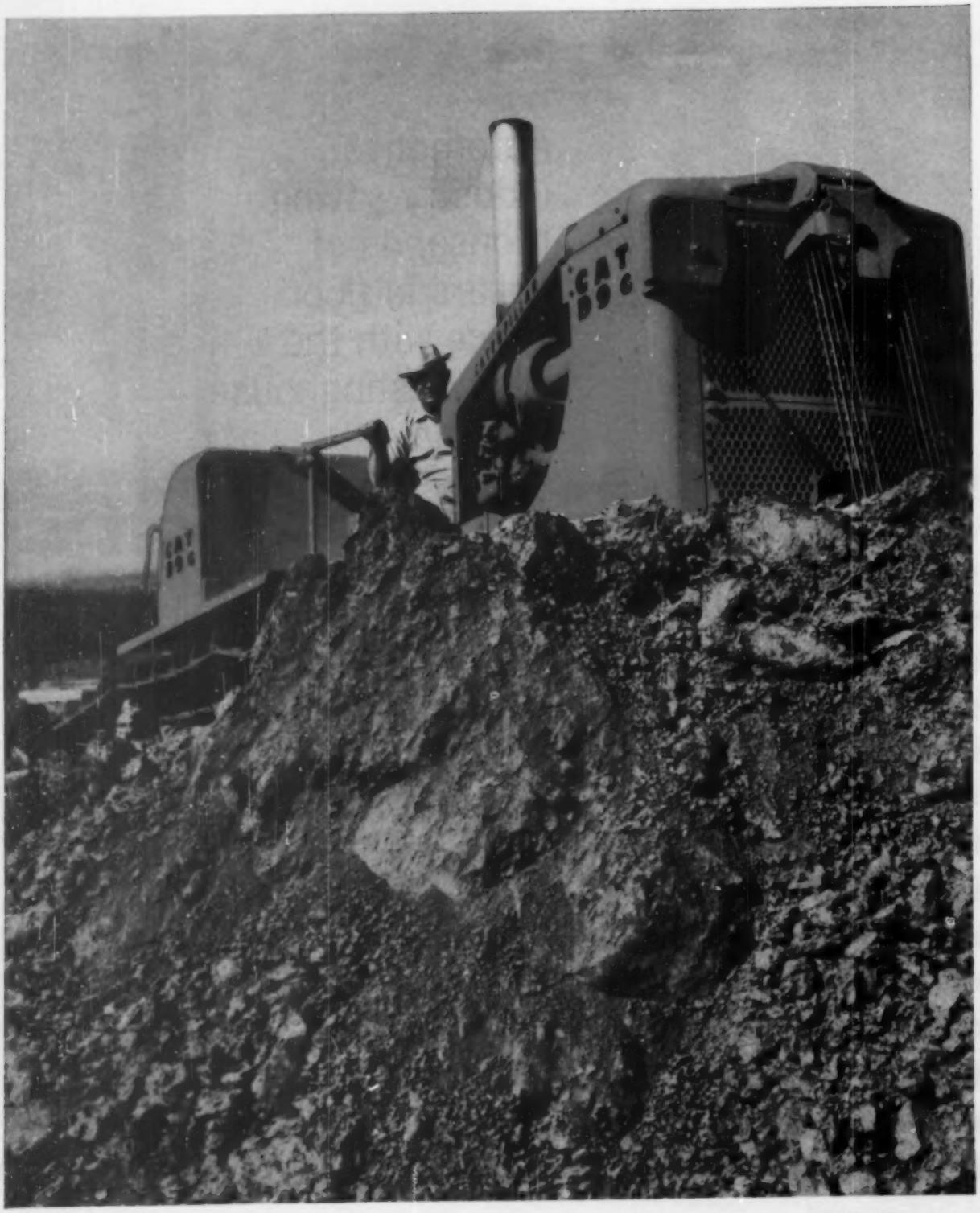
one old style relay. Besides being small, performance excels other machine tool relays. Learn how it can help you gain valuable floor space for more productive uses. Contact your Westinghouse sales engineer or write: Westinghouse Electric Corporation, Standard Control Division, Beaver, Pennsylvania. *You can be sure . . . if it's* **Westinghouse**

Automotive industry saving thousands of dollars in floor space with the new Westinghouse BF Relay



Westinghouse BF Relays control six transfer lines built for the automotive industry by F. Joseph Lamb Co., Detroit.

What makes D9s so



strong? And last so long?



All Cat-built tractors *must* be able to take it—they lead a hard life. Especially the big, new D9G whose ferocious snarl is the result of a whopping 385 flywheel horsepower. That's an increase of 100 hp since the first D9 was introduced 5 years ago. It means that from stack to track, steel components have to be far stronger, more rugged. Solution: Caterpillar uses USS Alloy Bars for critical power train parts such as the final drive pinion. Says Caterpillar, "USS Alloy Bars meet our rigid specifications for strength, hardenability, durability, and precise tolerances."

USS Alloy Bars are not only exceptionally strong and durable, but they have excellent fabricating characteristics as well. Distortion during heat treatment and machining is an absolute minimum. USS Alloy Bars retain dimensional accuracy during quenching. And USS Alloy Bars are available in the widest range of sizes, shapes and grades in the industry. Order what you need from your nearest U. S. Steel sales office or Steel Service Center. USS is a registered trademark of United States Steel.

United States Steel Corporation • Columbia-Geneva Steel Division • Tennessee Coal and Iron Division • United States Steel Supply Division • United States Steel Export Company

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

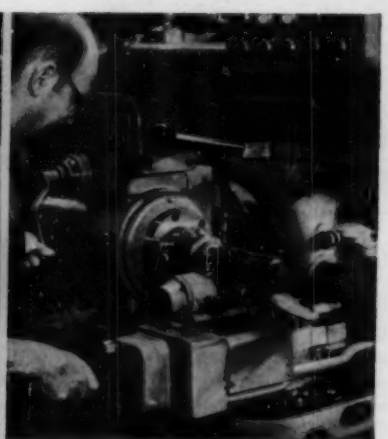
USS **United States Steel**



High-speed saw cuts USS Alloy Bars into proper lengths for finished parts.



Transmission shafts are rough ground to general tolerances before finish grinding.



Hob operation cuts teeth into shaft—precise tolerances are extremely important here.

This mark tells you a product is made of modern, dependable Steel.

Here's 0.1° Sensitivity at a Competitive Price!

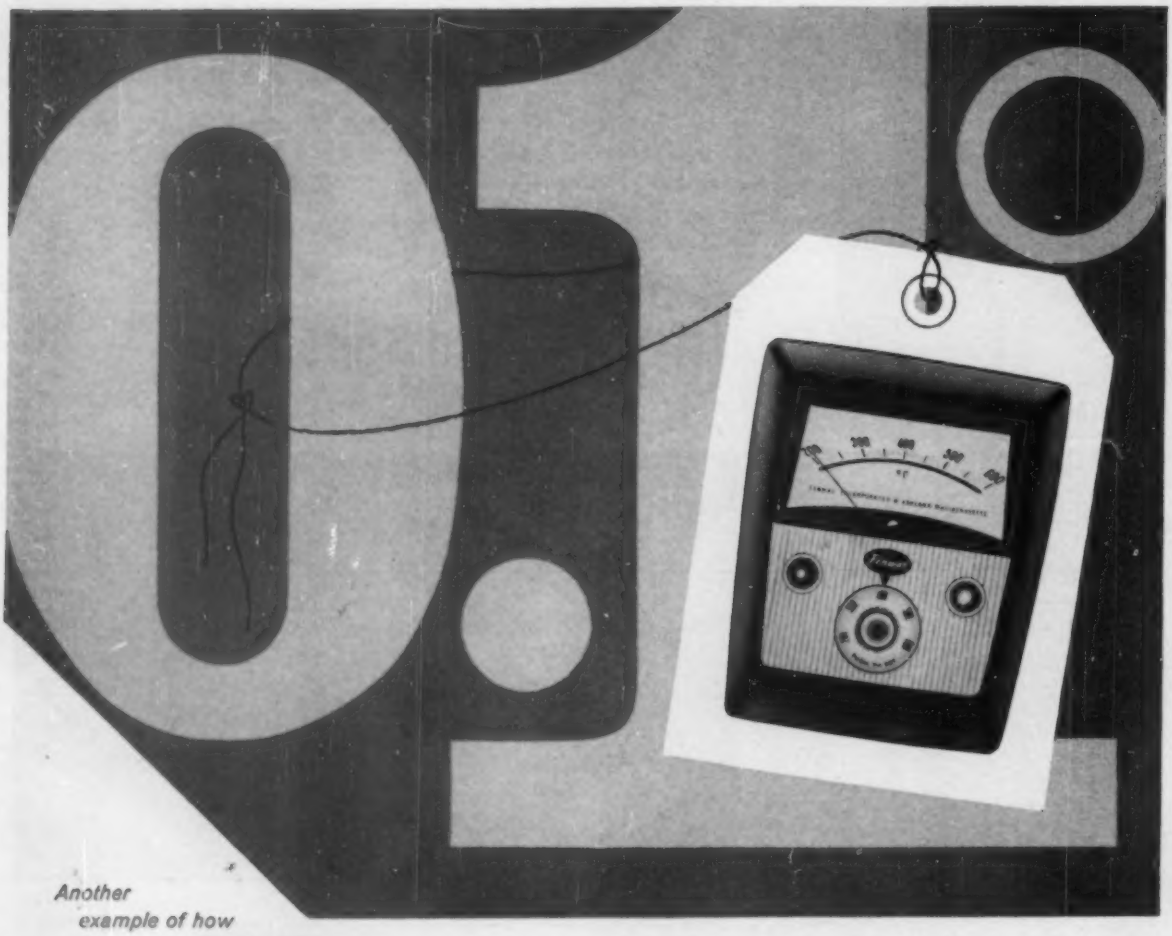
... Fenwal's New "561" Temperature Controller

The new "561" indicating controller responds to temperature changes of 0.1° or less! And is yours at a competitive price! These two features alone make it an instrument you should investigate... but there's more!

You can choose from five standard temperature ranges . . . within the span of −50 to 600°F. Furthermore, scales start and end within *your* ranges, permitting larger graduations, better legibility, easier readout. And control and indication are separate but simultaneous. *Should your indication fail the "561" will continue to control with complete accuracy.*

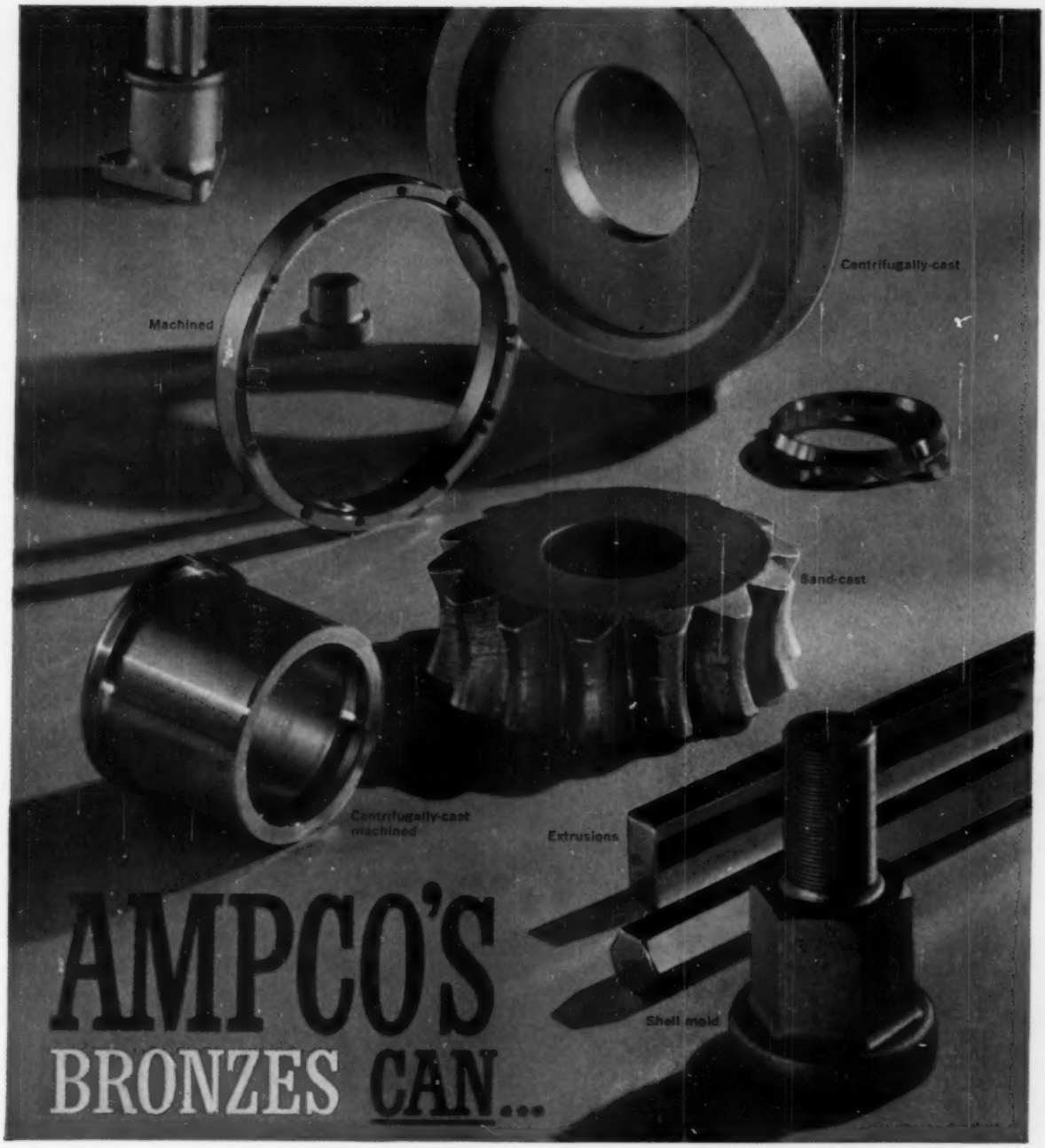
This precise instrument gives unvarying performance. Its indication and control will not vary with fluctuations of input voltage nor changes in ambient temperature. It offers the option of either ON-OFF or proportional control . . . has 10 AMP/120 VAC relay capacity. Smartly styled to complement modern industrial machines and interiors, *the "561" offers you all these extras at a competitive price.*

A Fenwal engineer will be glad to supply information on the "561", or any other temperature control in Fenwal's broad line. Write Fenwal Incorporated, 1911 Pleasant Street, Ashland, Massachusetts.



Another example of how

Fenwal CONTROLS TEMPERATURE . . . PRECISELY



AMPCO'S BRONZES CAN...

when other metals can't!

If your operation is so punishing on metal parts that you're plagued with constant, expensive replacement — better look into Ampco's bronzes!

Ampco alloys work where other metals wilt. The peculiar — but desirable — characteristics of these copper-base alloys make them ideal for applications that destroy most metals. Corrosion. Erosion. Physical attack, like abrasion . . . or metal-to-metal wear. All of these abusive forces are countered by Ampco!

Ampco's two basic products are AMPCO® metal, a premium quality bronze that costs a little more, but delivers a *lot* more . . . and AMPCOLOY®, a series of better-than-usual commercial grade bronzes. All are available in sand-cast, centrifugal-cast, shell-molded, extruded, rolled, wrought, forged, fabricated, and finished-machined forms from Ampco's unmatched metal-producing facilities.

Get the whole story on these miracle-metals. Write for "AMPCO" — a full color, illustrated booklet — yours for the asking.

AMPCO METAL, INC., MILWAUKEE 1, WISCONSIN / HUNTINGTON PARK, CALIFORNIA / GARLAND, TEXAS

6-33

Select from *four*, big, basic families . . .

VT2	VT4	TV8	VT20
1.5-1.8 amp	3.5-4.75 amp	7.5-10 amp	20 amp

- Get *immediate delivery* from your distributor or the factory on 39 stock sizes and types: single transformers, tandems, with and without overvoltage, low voltage, single-phase, three-phase, cased, fixed mounting, portable, 120V and 240V.
- Choose from *many* special features: tandems, multi-taps, motor drives, concentric controls, special windings, shafts of all types, and job-matched enclosures among others.
- Specify from innumerable possibilities in "custom-engineered" combinations with unusual reciprocating motor drives, complex double-track arrangements, rheostats, toggle switches, and precision switches.
- Pick 36V transformers in 5-, 12-, or 22-amp ratings for your transistorized circuits.



the big

From every aspect, you'll find that Ohmite is a good place to purchase variable transformers. If you need a "special" . . . okay, just tell Ohmite. Need some engineering assistance? All right! What about quantity? Ohmite can handle big orders, medium, and small. The Ohmite VT line of variable transformers is broad and deep. So is the service. Find out by specifying "Ohmite" on your next requirement for variable transformers.



choice
in fine variable transformers

Rheostats Power Resistors Precision Resistors Relays
R. F. Chokes Germanium Diodes Micromodules
Variable Transformers Tantalum Capacitors Tap Switches

OHMITE

OHMITE
MANUFACTURING COMPANY
3618 Howard Street, Skokie, Illinois

Circle 240 on Page 19



What's new in drafting materials? Get it firsthand from Dietzgen

Today's engineering and production achievements are miracles of teamwork. The talents of scores, hundreds and even thousands of engineers, architects, technicians, draftsmen, and specialists are coordinated through rapid and accurate interchange of ideas. Technical drawings are the primary communication media of this progress and their preparation represents approximately 70% of the total engineering costs.

Dietzgen's long experience and continuing research plays an important part in providing new techniques, materials, and equipment to boost drafting room efficiencies. For example: Dietzgen "no-print" gridded drafting media promote faster, more accurate sketch work and eliminate many tedious re-drawing operations. New Dietzgen sensitized drafting media have pioneered such time-saving cost-cutting techniques as template drafting, registration drafting, and new methods for retrieving drawings which have lost their line density.

No organization can afford to ignore the advantages and economies these new drafting media provide. Now is the time to try, test and prove the value of Dietzgen drafting materials in your engineering-drafting departments.

Write today for the new Drafting Media brochure. This 28-page booklet not only presents what's new in drafting materials, it also explains and illustrates their many uses. Address your request on your company letterhead and ask for Publication MKTG3-L160.
EUGENE DIETZGEN CO. Chicago 14, Illinois.

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EVERYTHING FOR DRAFTING, SURVEYING & PRINTMAKING

PRINCIPAL OFFICES:
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Circle 251 on Page 19

OPENING NEW HORIZONS

. . . in economical power application

98% PLUS OPERATING EFFICIENCY
MORE POWER PER CYLINDER DOLLAR
PROVEN LEAKPROOF OPERATION
GREATEST SELECTION EVER OFFERED
SAFE UNDER SEVERE LOADS
SAFE WITH ALL KNOWN HYDRAULIC FLUIDS
SAFE UNDER TEMPERATURE EXTREMES
DAMAGE-PROOF PISTON RODS



Miller HYDRAULIC CYLINDERS

Flick-Reedy . . . *Winner of "Plant of the Year" Award and "Silver Anvil" Public Relations Award*

Miller

MORE SAVINGS!

Our ultra-modern, new "Plant of the Year" with its special facilities and operating economies enable us to offer an **extra 10% price savings** on our big "stock" selection of:
Model "H" (Hyd.) Cylinders, 1½" through 8" bores;
Model "J" (Hyd.) Cylinders, 1½" through 14" bores;
Model "A" (Air) Cylinders, 1½" through 14" bores.
Strokes up to 36", cushioned and non-cushioned.

Full Details On Request



Miller Hydraulic Cylinders make impossible applications look easy. With Teflon Seals, Case-Hardened Rods (50-54 Rockwell C), Patented "Shef" Tubing End Seals, and other exclusive *standard* features, these cylinders are practically damage-proof, are ultra-dependable under pressure and temperature extremes, and provide leakproof sealing with ALL hydraulic fluids. Built to *exceed* J. I. C. Specifications, these cylinders are achieving new highs in production and operating economies in thousands of plants. Two great lines: Power-Packed Model H for 3000-5000 psi and Job-Rated Model J for 500-2500 psi. All bores, strokes and mounting styles. Big "Stock" selection for immediate shipment at substantial savings.

Write for literature.

R

MILLER FLUID POWER
DIVISION OF FLICK-REEDY CORPORATION

7N016 York Road, Bensenville, Illinois

COUNTERBALANCE CYLINDERS • BOOSTERS

Circle 252 on Page 19



Standard Forge & Axle Co. forges 5-inch by ½-inch Pittsburgh Seamless Mechanical Tube ends down to 2⅛" solid steel wheel spindle ends (cross section above). The Montgomery, Ala., plant then machines and grinds bearing surfaces to .0005-inch tolerance to produce single-piece, 20,000 pound capacity trailer axles. Trailer operators benefit from higher payloads because . . .

They Throw Away The Holes—And Save Weight

The trick in making a seamless steel tube is piercing a hole in a round of solid steel.

But Pittsburgh Steel Company's Seamless Steel Mechanical Tubing makes the full circle in production of trailer axles at Standard Forge & Axle Co., Montgomery, Ala.

Standard, in effect, throws away the holes by forging the tube ends down to solid steel again, leaving only a hollow steel center and spindle section.

The result: a lightweight, one-piece trailer axle made entirely from a single length of seamless tube—including load bearing wheel spindles, precision ground for bearing and seal seats.

The advantage: assured strength and safety of seamless steel, plus, for example, reduced axle weight for trailer operators in a 20,000 pound capacity axle.

Starting with a seamless steel tube 5" x ½" x 87⅛" for this particular axle, Standard upsets both ends, then swages them down to the shape of a spindle with a 2⅛" solid end.

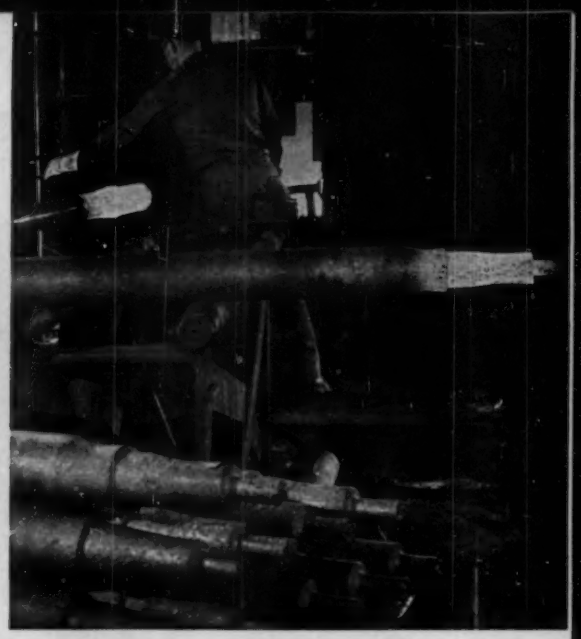
That's deformation of the roughest kind.

But Pittsburgh Seamless Mechanical Tubing takes it in stride, then bounces back under heat treatment with the physical properties required for precision finishing of the critical spindle surfaces, and the toughness necessary for a long life in hard service.

And that kind of performance takes seamless steel tubes with exceptional internal soundness, consistent grain structure, and chemical and dimensional uniformity.

Pittsburgh C-1040 grade Seamless Mechanical Tubing supplies these properties consistently—for this type

After upset, Pittsburgh Seamless Mechanical Tubes, with 5-inch OD and ½-inch wall, are swaged to solid steel spindle shape on drop forge, at right. Standard's heat treating process refines grain, restores toughness of steel.





Standard also produces high-strength inserted spindle trailer axle by inserting forged alloy steel spindle with 4.065-inch OD into 4.040-inch burnished ID of 5-inch seamless steel tube under 50,000-pounds pressure.



Standard Forge & Axle Sales Manager James A. Rumbley says Pittsburgh Steel Company, as longtime major supplier of seamless mechanical tubes, "leaves nothing to be desired in product or service."

axle and for Standard's high-strength inserted spindle type.

James A. Rumbley, Standard's sales manager, says:

"Trailer axles are high-weight carrying members subject to tremendous load shocks. So we use the finest materials available to assure our customers trouble-free service. Seamless steel mechanical tubes help us to do that, with complete safety and at less weight.

"For many years, Pittsburgh Steel Company has been one of our major tubing suppliers. It has left nothing to be desired either in product or service."

That's standard practice with Pittsburgh Steel—whether supplying seamless mechanical tubing to Standard's specific requirements, or to yours. Be certain with Pittsburgh Seamless. Contact one of the district offices listed below.

Pittsburgh Steel Company

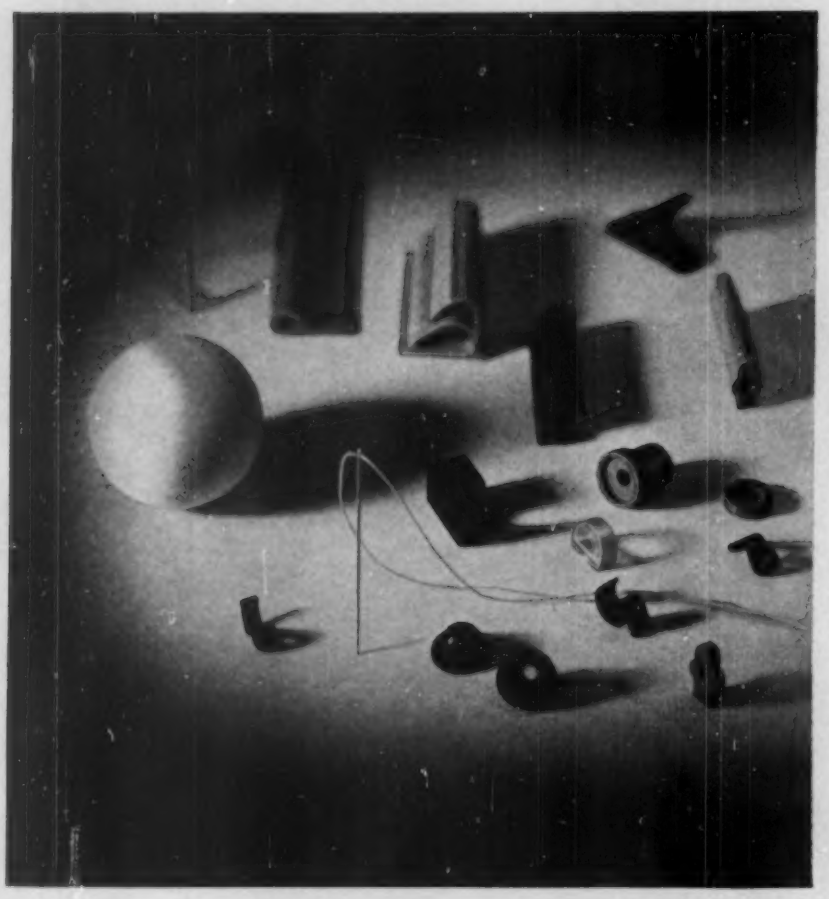
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DISTRICT SALES OFFICES

Atlanta	Cleveland	Dayton	Los Angeles	Pittsburgh
Chicago	Dallas	Detroit	New York	Tulsa
		Houston	Philadelphia	Warren, Ohio

Circle 253 on Page 19

Years of processing rubber parts enable Garlock to practically "thread the needle" with accuracy to meet your size and tolerance requirements.



When you need intricate

MOLDED AND EXTRUDED RUBBER PARTS

. . . depend on Garlock to meet your requirements with utmost precision. No design is too complex, no size too small, no tolerance too exact for the unmatched combination of Garlock experience, skill and production equipment. The minute your specifications are received, Garlock "know-how" goes to work . . . selecting and compounding the right combination of basic materials . . . making the die or mold to exact tolerances . . . insuring the excellence of the finished part through twenty exacting tests and controlled quality during development and production.

Choose from a wide variety of rubbers, each carefully chosen and processed to meet your exacting needs. SBR for general use . . . Natural Rubber for high tensile strength . . . Neoprene for oil and abrasion resistance . . . Silicone Rubber for high and low temperature service . . . Viton* Rubber for extreme temperature and solvent resistance . . . Nitrile and Butyl compounds where their special qualities are required. Your Garlock representative is fully qualified to assist you in selecting the proper material. Call him at the nearest of the 26 Garlock sales offices and warehouses. Or, write for Catalog AD-167, Garlock Inc., Palmyra, N. Y.

Canadian Div.: Garlock of Canada Ltd. **Plastics Div.:** United States Gasket Company. **Order from the complete line** of quality Garlock products ... Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Stock and Parts. *DuPont Trademark



GARLOCK

Cleveland Speed Variator is the Best Answer to *Precision Control* of Variable Speed Output



Advanced-designed Cleveland Speed Variators—available in 18 models ranging from fractional to 16 hp at 1750 input RPM—accurately provides dependable, infinitely variable speed control. They give stepless speed over a full 9:1 range—from ¼ to 3 times input speed. Instant smooth change of output speed can be adjusted by either manual, automatic or remote control. Precise adjustments are always made with accurate adherence to settings.

Thousands of Variators are in daily use on such varied industrial equipment as cigarette-making machines, textile machinery, metalworking machinery, pharmaceutical equipment, transfer tables, conveyors and experimental and testing equipment of many types.

Check these major Variator advantages:

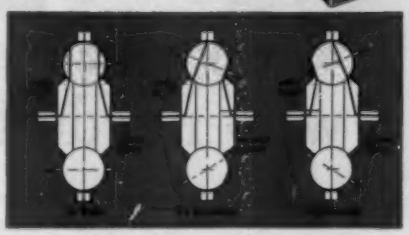
- An extremely compact unit with input and output shafts in line and rotating in the same direction
- Almost any input speed up to 1800 RPM can be used —either clockwise or counterclockwise rotation
- Rated for constant horsepower output over a 9:1 or 6:1 range; or for constant output torque over a 6:1 range
- Speeds infinitely variable over entire range of adjustment
- No slippage—positive torque response mechanism adjusts in direct proportion to the loads encountered
- Long life and minimum maintenance due to absence of belts or complicated linkages
- Ample bearing support for overhung pulleys on both input and output shafts

Write today for free Bulletin K-200 containing detailed description, photographs, sectional drawings, rating tables and specifications.

Simple in Operation... Built for Long Life



The Variator is an extremely compact unit with input and output shafts in line, rotating in the same direction. It incorporates ample bearing support to carry overhung pulleys.



Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with the drive discs. Relative shaft speeds are adjusted by changing position of axles on which the balls rotate.

Cleveland Worm & Gear Division
Eaton Manufacturing Company
3287 East 80th Street • Cleveland 4, Ohio

CLEVELAND SPEED VARIATOR

Circle 255 on Page 19



TO THE ENGINEER

who needs the magic of mercury

If you're stymied by switching problems in data processing, automatic control or high-speed keying, then consider the unusual attributes of AE's Series V51 mercury-wetted contact relay.

This fleet switcher can be driven at speeds up to 100 operations per second, completely free from contact bounce. It requires no maintenance within its life of over a billion transfers. The contacts can switch dry circuits or handle loads up to 250 volt-amperes. Operate and release time is approximately 3 milliseconds.

Contact and armature assemblies of the V51 are hermetically sealed in a glass capsule with a high-pressure hydrogen atmosphere. Mercury wetting continuously renews the contacts, eliminates wear, erosion, welding and sticking. Operating sensitivity is 250 milliwatts, minimum.

AE engineers will be glad to aid in applying the V51 to your designs. Ask for Circular 1988 covering full specs on the V51. Write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois.



AUTOMATIC ELECTRIC

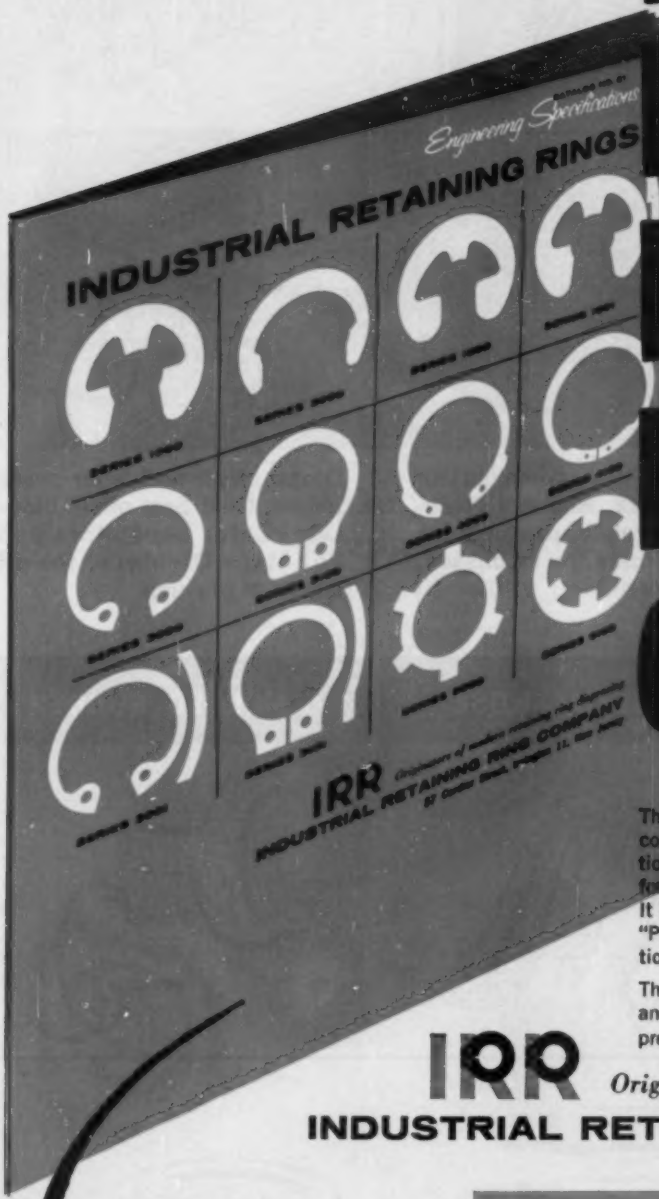
Subsidiary of

GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

For YOUR File . . .

New! Industrial Retaining Ring Catalog



This new Industrial Retaining Ring Catalog, No. 61, contains complete information and engineering specifications on IRR Internal and External Retaining Rings—both for axial and radial assembly—from sizes .040" to 4.125". It also has information of the exclusive, time-saving, IRR "PRE-STACKED" Axial Assembly Rings as well as information on IRR Pliers and Accessories.

The Industrial Retaining Ring Catalog is easy to work with and from. It will greatly assist in design, purchasing and production.

IRR *Originators of modern retaining ring dispensing*

INDUSTRIAL RETAINING RING COMPANY

57 Cordier Street, Irvington 11, New Jersey

Use for FREE Samples and Catalog

INDUSTRIAL RETAINING RING COMPANY
57 Cordier Street, Irvington 11, N. J.

Please, send me samples of Industrial Retaining Rings and the new IRR Catalog No. 61.

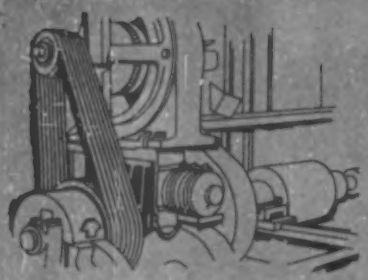
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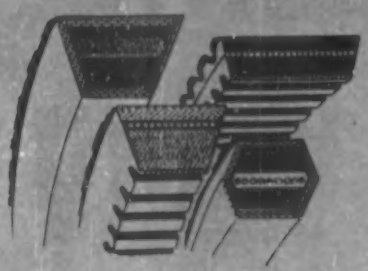
Company .....

Street .....

City ..... Zone ..... State .....

V-BELT DRIVES

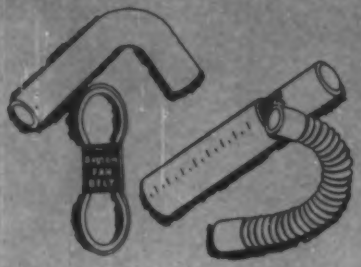




Dayco offers the only complete line of V-Belts in the industry for every power transmission need—from fractional to 1,000 and more horsepower.

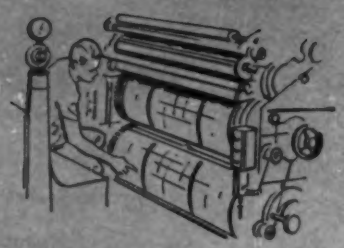
AUTOMOTIVE PRODUCTS

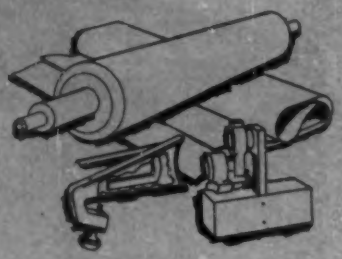




Dayco provides a complete line of Fan Belts, Radiator Hose, and other rubber products for passenger cars, trucks, busses, and tractors.

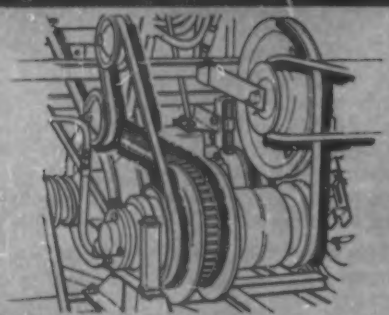
PRINTING PRODUCTS

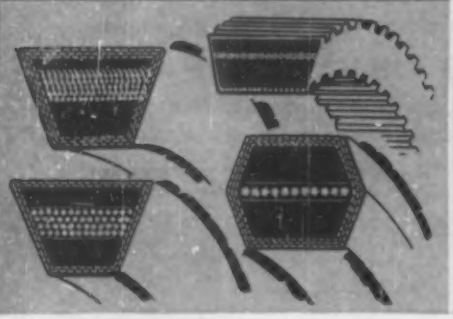




Dayco offset and letter press rollers, Gold Seal offset Blankets, Color Separators and Fountain Dividers, for all makes of presses.

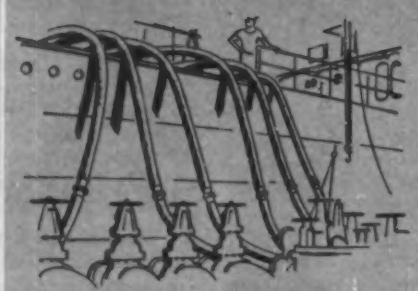
AGRICULTURAL V-BELTS

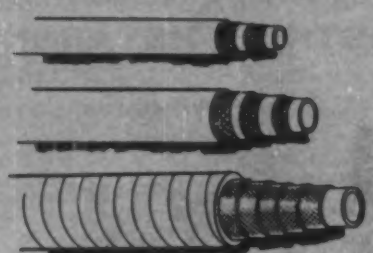




Dayco builds specialized V-Belts for the efficient transmission of power on all types of traction, propulsion and auxiliary farm implement drives.

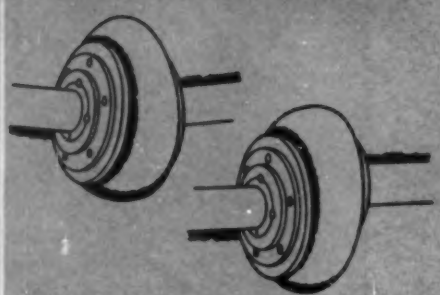
INDUSTRIAL HOSE

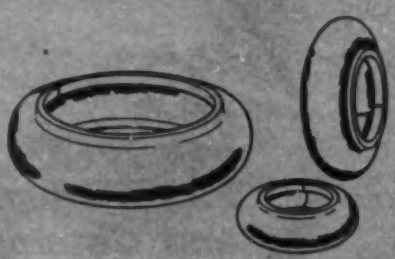




Dayco offers molded and horizontal braided, machine and hand wrapped fabric, and woven jacket constructions for all industrial applications.

MOLDED RUBBER





Dayco custom-engineered molded rubber, rubber-to-metal and rubber-and-fabric components for mechanical applications.

Dayton

Take your pencil. Get all the Dayton literature from your files. Make one little change. In place of Dayton write Dayco.

From now on, that's our product name. **Dayco** V-Belts. **Dayco** Hose. **Dayco** Printing Rollers and Blankets. **Dayco** Molded Rubber. **Dayco** Agricultural and Railway Drives.

Thus ends the difference between our corporate name, Dayco and our **former** product name, Dayton.

Let us repeat. The only thing that's changed is the name. The same high quality. The same broad line. The same friendly, helpful people. Only their product line is now **Dayco. DAYCO. D-A-Y-C-O.**

Dayco CORPORATION

Rubber Products Division — Melrose Park, Illinois

(Formerly known as The Dayton Rubber Company)

Circle 258 on Page 19

From Monsanto FluiDesign Service...

FLUIDS TO HELP TAME FIRE HAZARDS

Fire-safe hydraulic lifts, loaders, and launchers!

A hydraulic oil leak sprayed from an underground service elevator can ignite on contact with a welding torch, an arcing circuit breaker, even a broken light bulb. Chance ignition of a flammable fluid in a missile launcher, mobile lift, or weapon loader could cause disaster, destroying both missile and base. Monsanto can supply a whole series of fire-resistant *all-synthetic* hydraulic fluids that operate reliably over a wide temperature range. They will not corrode metals; will not clog pumps or valves; will resist change in composition or physical properties even after *years* of storage and service. For maximum fire protection of below-ground military installations, put Monsanto fluids specialists to work—checking out ignition dangers with *your* "hard" base hydraulic equipment designs.

MONSANTO FLUIDESIGN SERVICE OFFERS YOU:

1. Sophisticated application experience with fluids
2. Years-ahead research on new types of fluids
3. Time-saving facilities for testing new uses
4. More *job-proven* functional fluids than any other manufacturer in the world
5. Design-oriented *know-how* to help you develop more compact, safer, and more reliable equipment



TYPICAL PROPERTIES OF A FEW MONSANTO FLUIDS	OPERATING TEMPERATURE RANGE (°F)	VISCOSITY (centistokes @ °F)	POUR POINT (°F)	MAXIMUM LONG TERM BULK TEMPERATURE (°F)	SPECIFIC GRAVITY 25°/25°C	
SKYDROL® 7000	−40 to 200	15.5 @ 100 4.00 @ 210	<−70	200	1.08	
SKYDROL 500A	−65 to 225	2300 @ −65 11.5 @ 100 3.92 @ 210	<−85	225	1.07	
PYDRAUL® 60	−25 to 200	10.0 @ 100 2.45 @ 210	−70	200	1.09	
PYDRAUL 150	−15 to 200	30.8 @ 100 8.0 @ 210	−55	200	1.13	
PYDRAUL F-9	+50 to 300	47 @ 100 5.5 @ 210	0	300	1.28	
PYDRAUL A-200	+50 to 300	31 @ 100 2.86 @ 210	+10	300	1.42	
PYDRAUL AC	+60 to 300	88.2 @ 100 5.15 @ 210	+20	300	1.35	
OS-81	+50 to 300	34.0 @ 100 3.1 @ 210	+20	300	1.40	

THESE DIELECTRICS AND FIRE-RESISTANT FLUIDS

AT "HARD" BASES

Fire-safe electrical generation and distribution!

If you are designing, installing, or operating electrical power systems for below-ground service, let Monsanto guide you to greater fire safety for these vital installations. Oil *under ground*, in bulk storage or in service, can be hazardous—far more critical than above ground. Monsanto fluids assure greater safety—with *fire-resistant turbine lubricants*, *fire-resistant dielectric fluids* for *high confidence level* transformers in substation distribution points. Transformers filled with Monsanto fire-resistant askarels have been used for years by major utility companies to assure safe, reliable performance of their equipment. Build maximum fire safety into your ground support equipment with Monsanto fluids that eliminate fire hazards.



BE SURE TO GET YOUR FACT-PACKED FLUIDESIGN FILE. WRITE ON YOUR LETTERHEAD TO:

Monsanto

Monsanto Chemical Company
Organic Chemicals Division
FluiDesign Service, Dept. 4454A
St. Louis 66, Missouri

	BULK MODULUS psi @ 77°F	SURFACE TENSION (dynes/cm)	COEFFICIENT OF THERMAL EXPANSION	HARDWARE COMMERCIALLY AVAILABLE FOR FLUID USE	FLUID STATUS	FIRE RESISTANT
	328,000	**28.9**	**0.00042**	**YES**	**Commercially Available**	**YES**
	308,000	**30.8**	**0.00045**	**YES**	"	**YES**
	328,000	—	**0.0004**	**YES**	"	**YES**
	319,000	—	**0.00042**	**YES**	"	**YES**
	387,000	—	**0.00041**	**YES**	"	**YES**
	400,000	—	**0.0004**	**YES**	"	**YES**
	375,000	—	**0.0004**	**YES**	"	**YES**
	—	—	—	**YES**	**Development Product**	**YES**

ASSURE RELIABILITY AND SAFETY

Circle 259 on Page 19

Why design to a proprietary standard?

Compare overall stack heights shown in the table below, and you'll see what we mean. Listed are so-called "standard" heights of ¼" 3-ring fabricated "V" packings offered by six major manufacturers. Overall heights range from a low of ⅝" up to 1¾" high . . . *a variation of more than* ½".

COMPARATIVE STACK HEIGHT OF FABRICATED "V" PACKINGS PLUS ADAPTER NOW OFFERED

C/S	SOURCE	3/SET
¼"	Mfgr. A	25/32
	" B	41/64
	" C	1 9/64
	" D	45/64
	" E	5/8
	" F	23/32

This means that in laying out a gland for fabricated "V" packings, the designer must first determine which manufacturer he wants to buy from before he completes his design. And once the gland is made for this particular brand of packing, replacements of the same brand are almost mandatory. Another handicap—switching to a leather or homogeneous packing later would be extremely difficult because of the difference in stack heights.

The use of Standard J.I.C. stack heights for fabricated "V" packings is the obvious answer to this problem. Yet, today Houghton is the only packing manufacturer who offers you uniform stack heights for *all three* major "V" packing materials—fabricated, homogeneous and leather—making them interchangeable with respect to dash number, O.D., I.D. and stack height.

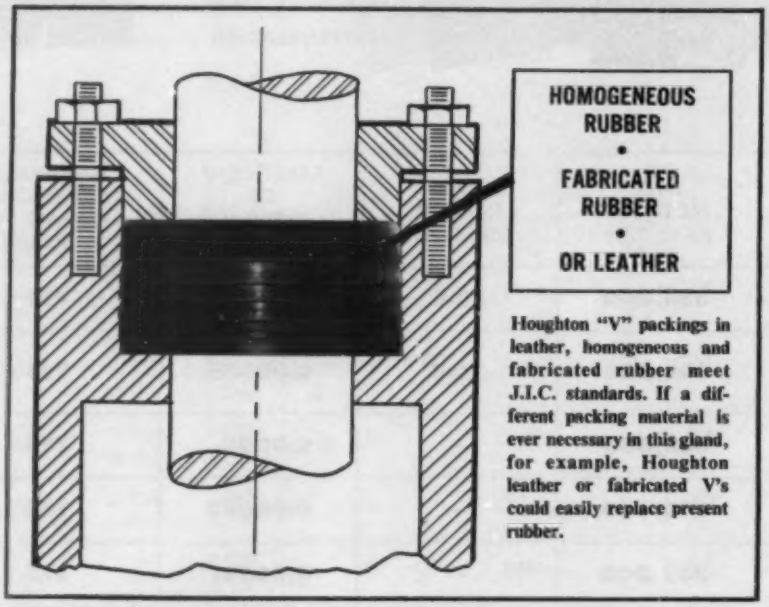
With Houghton "V" packings, you don't have to compromise in material to meet your operating requirements. Simply select the material best suited to the job and you know it will fit automatically.

Complete interchangeability among Houghton leather, rubber, and fabricated "V" packings is the solution to a long-standing problem —the choice of material for an application that demands properties no single packing material can provide.

Now, the identical stack heights of all Houghton V's permit *unlimited* switching of V combinations in any gland, either with rings of the same material, or different materials within a set.

You can use a leather V for anti-extrusion, strength, and low friction with rubber rings for wiping efficiency and low cost. You can switch from homogeneous rubber to fabricated to gain extra strength. You can even use V's of all three materials in the same gland.

Leadership in packing standardization is another reason major hydraulic and pneumatic equipment manufacturers consider Houghton "packing headquarters". Houghton is also the only manufacturer who offers a *complete* line of packings and fluids for almost any industrial hydraulic system. This experience in both fields is your guarantee of a completely unbiased recommendation of compatible materials . . . the very best for your particular application. For more information or help, call or write: E. F. Houghton & Co., 303 W. Lehigh Ave., Phila. 33, Pa.



Houghton "V" packings in leather, homogeneous and fabricated rubber meet J.I.C. standards. If a different packing material is ever necessary in this gland, for example, Houghton leather or fabricated V's could easily replace present rubber.

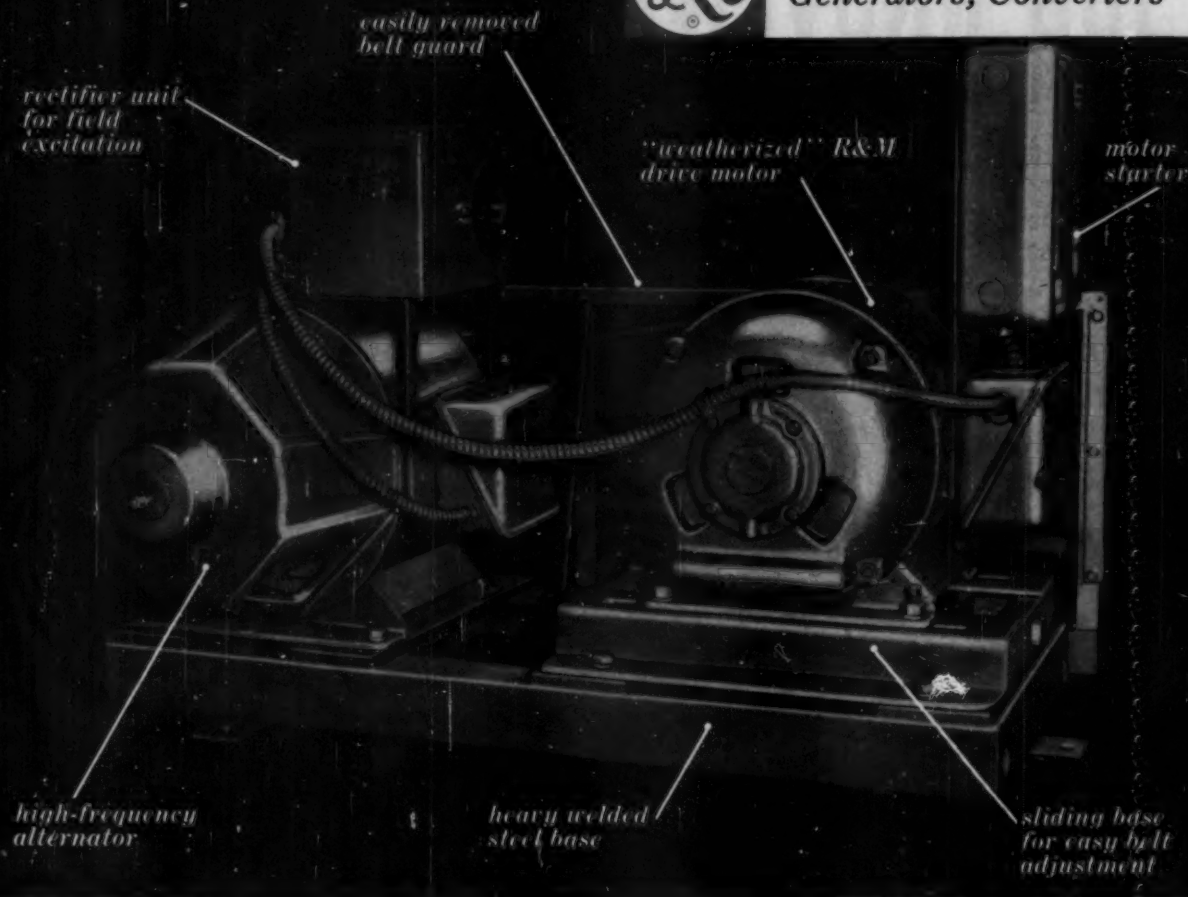
Houghton

INDUSTRY'S PARTNER IN PRODUCTION

Circle 260 on Page 19

high frequency

Generators, Converters



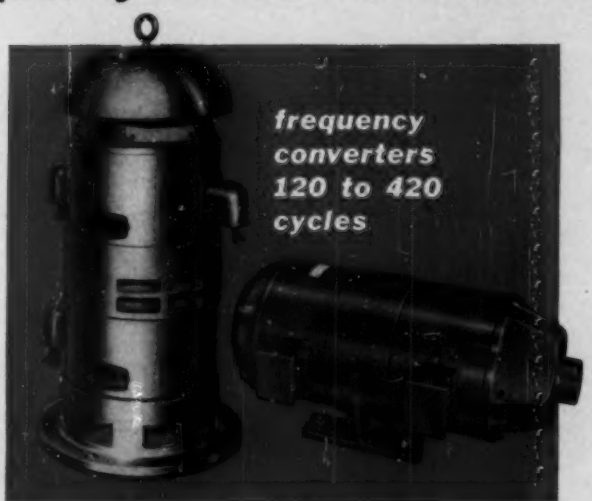
Compact High Frequency Power Generators



360 to 3300 cycles

R&M package high cycle generators provide dependable current beyond the practical range of frequency converters. Rugged revolving field construction is used in ratings of 1500 cycles and lower. Ratings above 1500 cycles are brushless inductor design. Excitation of DC alternator field is provided by simple silicon rectifiers, protected against short circuits by time-delay fuses. For changing output frequency, R&M can furnish variable pitch pulleys or variable speed drives. R&M's low-cost frequency converters make 220 volt-3 phase-120 through 420 cycle power available from 60 cycle supply . . . rated 2½ KW (horizontal construction) 5, 7½ and 10KW (vertical).

Write today for bulletin 515A-MD!

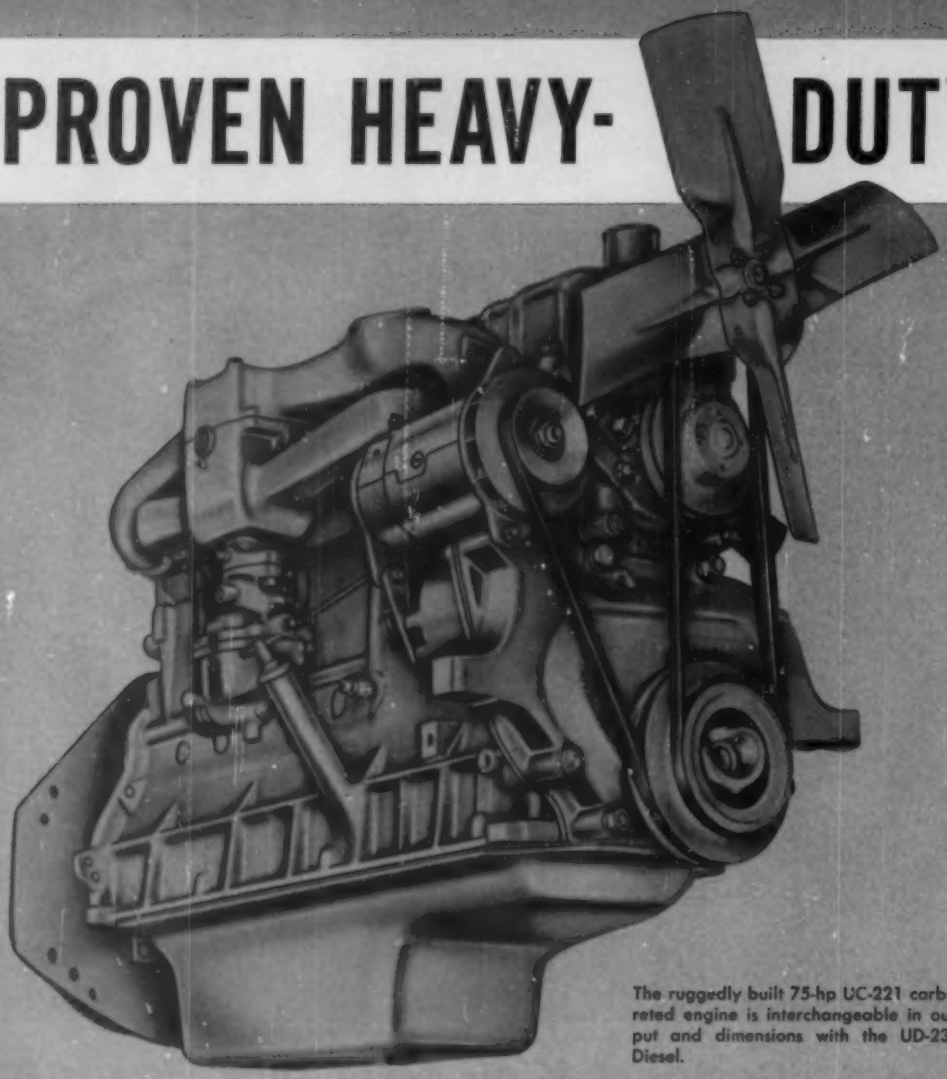


ROBBINS & MYERS, INC., Springfield, Ohio

Fractional and Integral HP Electric Motors • Electric Hoists and Overhead Traveling Cranes • Moyno® Industrial Pumps
Propellair® Industrial Fans • R & M-Hunter Fans and Electric Heat • Trade-Wind Range Hoods and Ventilators
Subsidiary companies at: Memphis, Tenn., Pico Rivera, Calif., Brantford, Ontario.

Circle 261 on Page 19

JOB-PROVEN HEAVY-DUTY



The ruggedly built 75-hp UC-221 carbureted engine is interchangeable in output and dimensions with the UD-236 Diesel.

BRIEF SPECIFICATIONS

ENGINE MODEL	DISPL. IN.	BORE, STROKE	LENGTH	WIDTH	HEIGHT	WEIGHT	FUEL	ENGINE HP @ RPM	POWER UNIT HP @ RPM
UC-263	263	3⅜ x 4.39	41⅝₂	23⅞	30²½₂	895	GASOLINE	95 @ 2400	91 @ 2400
							L.P.G.	89 @ 2400	82 @ 2400
							NAT. GAS	80 @ 2400	74 @ 2400
UC-221	221	3⅜ x 3¹⅛	41⅝₂	23⅞	30²½₂	895	GASOLINE	75 @ 2400	71 @ 2400
							L.P.G.	73 @ 2400	69 @ 2400
							NAT. GAS	65 @ 2400	60 @ 2400
UD-282	282	3¹⅛ x 4.39	41⅜	23⁴¾₄	30⅝₂	905	DIESEL	95 @ 2400	90 @ 2400
UD-236	236	3¹⅛ x 3¹⅛	41⅜	23⁴¾₄	30⅝₂	905	DIESEL	75 @ 2400	70 @ 2400

INTERCHANGEABLE POWER!

International brings you interchangeable diesel and carbureted engines in the 75-95 hp range...

These four International engines give you great design flexibility in a popular horsepower range. Interchangeable in size and power, two 75-hp and two 95-hp models give you a choice of diesel or carbureted operation. Factory-installed carburetors on the UC-221 and UC-263 equip these models to efficiently burn gasoline, LP gas or natural gas. The UD-236 and UD-282 incorporate the same features of economy and dependability that have made IH diesels famous. All four engines feature International's sure-fire push-button starting, full-length water jackets, and efficient thermostatic cooling.

Carbureted engines with diesel ruggedness!

Carbureted models are built with the same heavy-duty construction you find in the diesel engines. Many parts are interchangeable—counterbalanced 4-bearing crankshaft, deep I-block crankcase, long-life tri-metal bearings, heat-treated steel connecting rods, gear-driven induction hardened camshafts—all are built with diesel ruggedness, to add extra years to your carbureted power. This feature also cuts costs on maintenance and replacement parts.

Diesel engines at carbureted prices!

Interchangeability permits standardization of many parts and fixtures, and consequently promotes notable savings in the manufacture of these engines. The savings are passed along to you, and the result is a diesel engine—fully designed for heavy-duty diesel operation—at a price you would expect to pay for a lighter "automotive" model.

The complete IH line—62 engines from 8 to 385 max. hp—offers the greatest number of models, with the widest flexibility, in the most usable horsepower range. Find out today how International's progressive engineering techniques and wide power range can help you solve design problems in your products. Call or write to International Harvester Co., Engine Sales Dept., Melrose Park, Ill.

INTERNATIONAL®

IH ENGINES

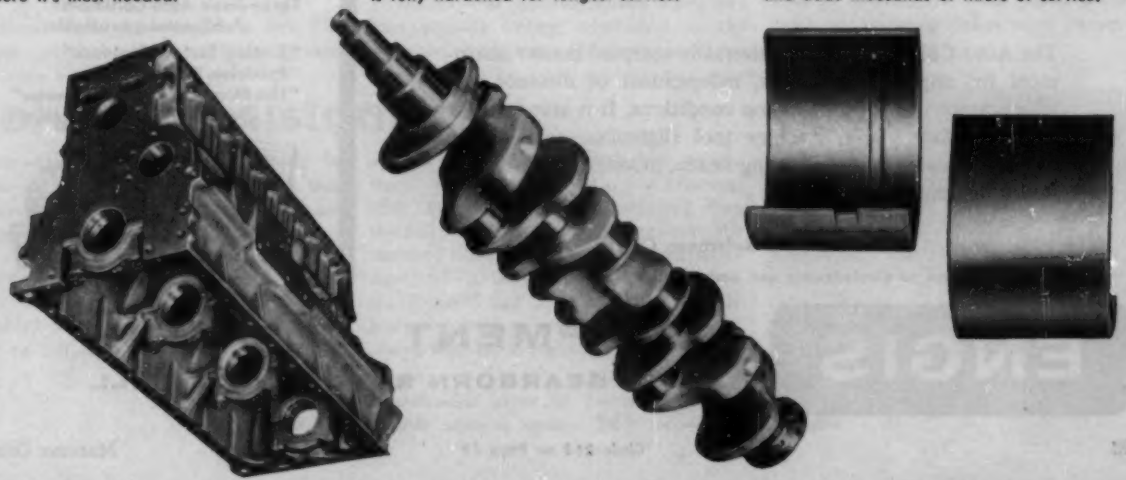
International Harvester Co.,
180 North Michigan Ave., Chicago 1, Ill.
A COMPLETE POWER PACKAGE

Circle 262 on Page 19

Deep I-block crankcase is common to both carbureted and diesel engines. Heavy ribs and extended construction (well below level of bearing caps) gives strength where it's most needed.

Counterbalanced crankshaft and fully machined combustion chambers produce super-smooth 6-cylinder power. Crankshaft has four high capacity main bearings and is fully hardened for longest service.

Tough tri-metal construction for connecting rod and main bearings—steel back, copper-lead center, babbit overlay—produces unmatched load carrying capacity, and adds thousands of hours of service.



new generation

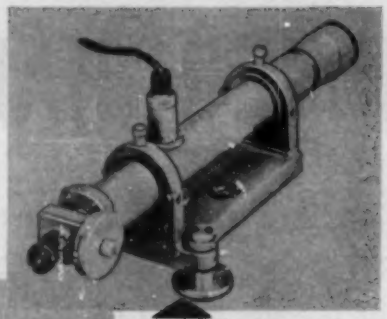
Auto-Collimators

UNIVERSAL,

PHOTO-ELECTRIC,

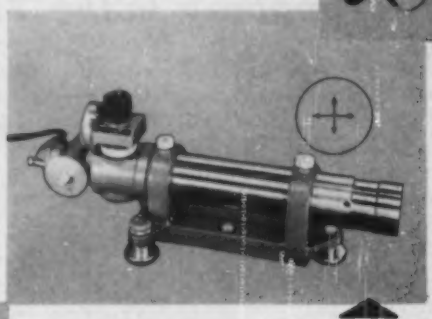
SIMULTANEOUS

TWO-PLANE READING



Angles Direct to .1 Sec.

Microptic Auto-Collimator TA-1 is the universally accepted master instrument to set up and check angles; range 10 minutes of arc; direct reading 0.1 second. With simple accessories it establishes squareness, parallelism, flatness, angles, circular spacing.



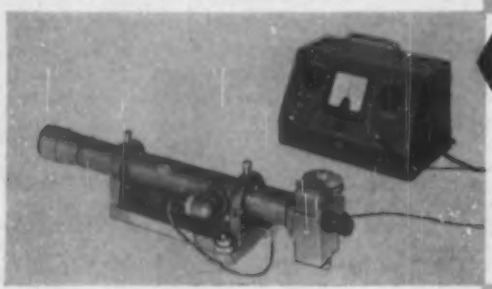


Photo-Electric Read-Out

The Photo-Electric Microptic Auto-Collimator TA-3 has setting accuracy of 0.05 second. Eliminates human factor—fatigue. Adjustable sensitivity and range; full visual optics.

Measures Two Planes at Once

Universal Microptic Auto-Collimator TA-51 reads angles in both planes simultaneously. Range, 10 minutes of arc; direct reading to 0.1 second. Assembled for straight or right angle viewing. High resolution; reflector distance to 100 feet.

Model TA-50 views two planes individually with non-rotating tube.

Universal Angle Dekkors

Micrometer Angle Dekkor TA-121—measuring range 20 minutes; direct reading to 0.5 seconds; reflector distance to 80 feet.

Angle Dekkor TA-130 (illustrated)— simultaneous measurement in both planes. Measuring range, 1 degree; direct reading to 30 seconds; reflector distance to 40 feet.





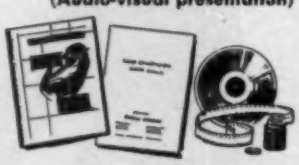
Miniature Auto-Collimator

The Minidekkor reads angles in both planes simultaneously. Range, 1 degree, direct reading to 1 minute; reflector distance to 12 feet; tube, 6" long.

The Auto-Collimator is the universally accepted master instrument for angle measurement, independent of distance and temperature under normal shop conditions. It is standard for testing surface plates, machine tool alignment, gear cutting devices, circular tables, dividing heads, missile guidance units and test equipment.

Three Basic Auto-Collimator Publications available:

"Testing Surface Flatness"
"Precision Polygons"
"The Microptic Auto-Collimator"
(Audio-visual presentation)



Ask for Data Reference CD-101

DIVISION OF ENGINEERING AND SCIENTIFIC INSTRUMENTATION

ENGIS EQUIPMENT COMPANY

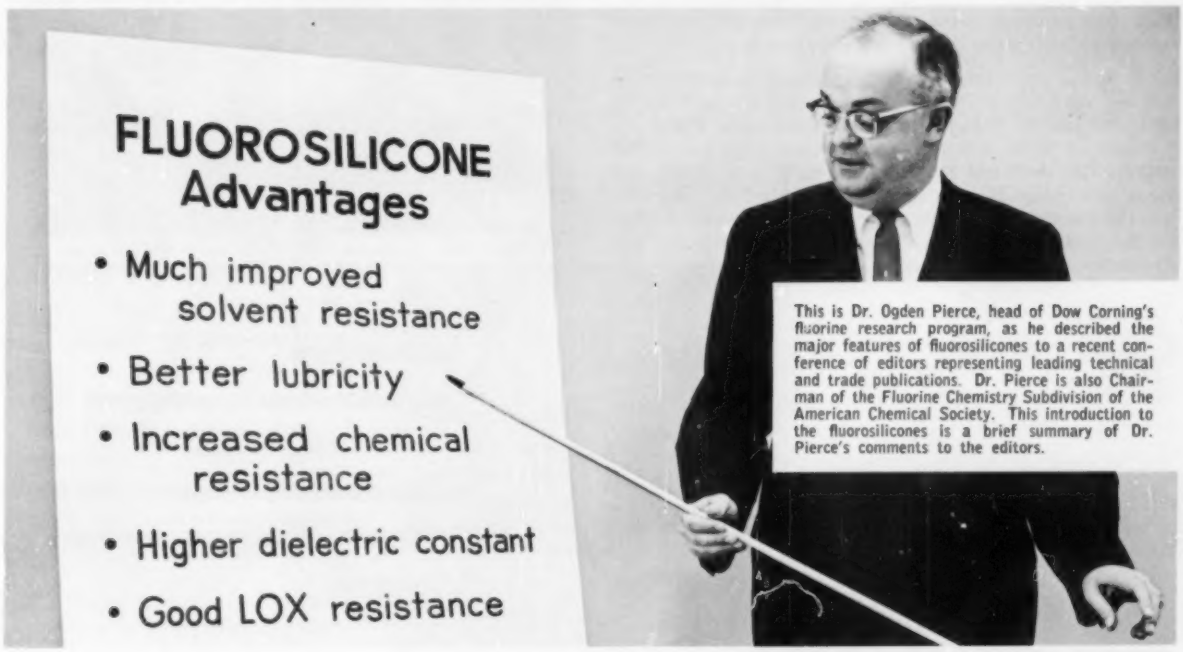
431 S. DEARBORN ST. CHICAGO 5, ILL

first in silicones

Dow Corning

SILICONE NEWS

for design and development engineers · No. 88



This is Dr. Ogden Pierce, head of Dow Corning's fluorine research program, as he described the major features of fluorosilicones to a recent conference of editors representing leading technical and trade publications. Dr. Pierce is also Chairman of the Fluorine Chemistry Subdivision of the American Chemical Society. This introduction to the fluorosilicones is a brief summary of Dr. Pierce's comments to the editors.

Meet the FLUOROSILICONES

The fluorosilicones are a new family of semi-inorganic polymers that offer a high order of solvent resistance, markedly improved lubricity, and all the more desired properties of standard silicone materials.

Chemically, most commercial silicones have methyl groups attached to the siloxane polymer. Fluorosilicones are produced by substituting fluoroalkyl groups for most of the methyl groups.

Fluorosilicones are available in four different physical forms: fluids, greases, compounds and rubbers. While the rubber-like materials were first introduced five years ago, the other fluorosilicones are completely new products.

They are, however, already advanced beyond the "experimental" stage, and pilot plant quantities are being produced for several military and industrial applications in which these new materials have proved to be effective and economical.

Suggested Uses

Greases — as all-temperature lubricants that provide lasting lubrication in the presence of solvents and chemicals.

Fluids—as defoamers of solvents and oils; as lubricants, damping media, flotation fluids and plasticizers in areas where solvent resistance is essential.

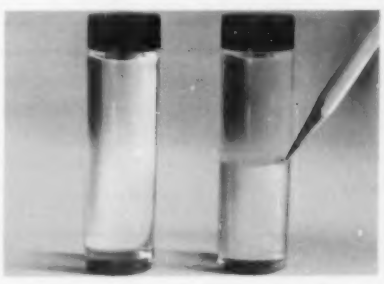
Compounds—as greaselike lubricants for valves, rubber O-rings, grommets and mounts in contact with liquid fuels, solvents and chemicals.

Rubbers—demonstrate outstanding resistance to solvents, jet fuels, oils and fluids over an operating temperature range of —80 to 500 F.

Solvent resistance

Fluorosilicone fluids are insoluble in most solvents (except the ketones and esters) and are incompatible with most petroleum oils.

In demonstration at right, both vials had been half-filled with perchloroethylene. A standard silicone fluid was then added to vial on left, and one of the new fluorosilicone fluids was added to vial on the right. You see both vials a few moments after they were well shaken and then allowed to stand at rest. Note how the standard silicone fluid has been completely dissolved by the perchloroethylene, while the fluorosilicone fluid separated quickly and completely as indicated by the meniscus in the vial at right.



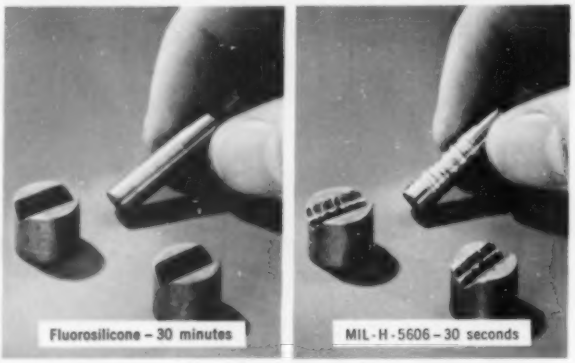
For technical information about all fluorosilicones, use coupon on next page or circle reference number 241 on reader service card

Meet the FLUOROSILICONES

Improved lubricity

That fluorosilicones have exceptional lubricity has been verified by both Falex tests and field experience.

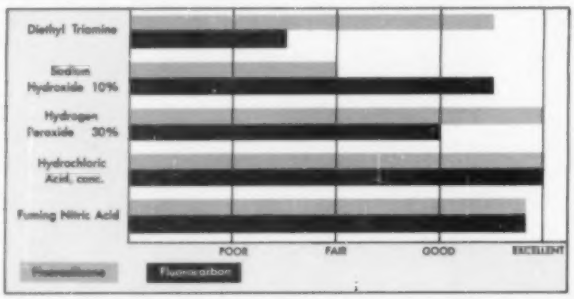
In the Falex test, a small shaft under load is rotated between two steel vee-blocks while immersed in the test lubricant. In the left photo you see shaft and vee-blocks tested in one of the new fluorosilicone fluids. Test time was 30 minutes; test load — 350 pounds. The shaft and blocks in the right hand photo were tested in standard MIL-H-5606 Hydraulic type oil. Test load was 350 pounds; however, test time was only *30 seconds!* Note the fluorosilicone set shows little scoring and wear even after 30 minutes testing.



Chemical resistance

The good chemical resistance of fluorosilicones is illustrated by the bar graph at right.

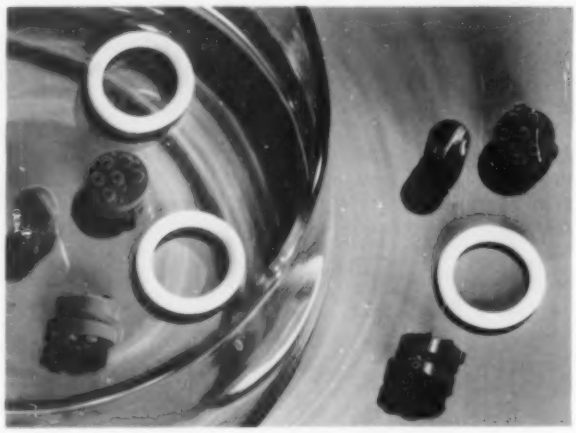
In determining these ratings, glass slides coated with a Dow Corning fluorosilicone compound were immersed to *half* the coating depth for 16 hours in diethyl triamine; 30% hydrogen peroxide; fuming nitric acid; concentrated hydrochloric acid, and 10% sodium hydroxide. Only the 10% sodium hydroxide exhibited any appreciable effect on the fluorosilicone compound.



Elastomers, too

Fluorosilicone rubbers, named Silastic® LS, have thoroughly proved their effectiveness in a variety of military and industrial applications requiring solvent-resistance, inertness and serviceability at both high and low temperatures. A look at the properties will explain why fluorosilicone rubbers have enjoyed rapid acceptance.

PROPERTIES	
Hardness, Shore A	50-65
Tensile Strength, psi	800-1000
Elongation, percent	150-170
Serviceable Temperature Range	—80 to 500 F
Fuel Resistance (JP-4), percent change after 30 days immersion	
Durometer	—5
Tensile Strength	—31
Volume	+10
Weather Resistance, after 31 months (3549 sun hours) at Florida Test Station — no visible effect.	



Silastic LS, fluorosilicone rubber parts at left show negligible swell after prolonged immersion in JP-4 fuel. Compare size with identical parts at right which were not immersed in the fuel.

Dow Corning Corporation, Dept. 6023, Midland, Michigan
Please send me technical data about all fluorosilicones

NAME_____

TITLE_____

COMPANY_____

STREET_____

CITY_____ ZONE____ STATE_____

SILICONE NEWS is published for design and development engineers by

first in silicones

Dow Corning

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.
CANADA: DOW CORNING SILICONES LTD., TORONTO OVERSEAS: DOW CORNING INTERNATIONAL S.A., ZURICH

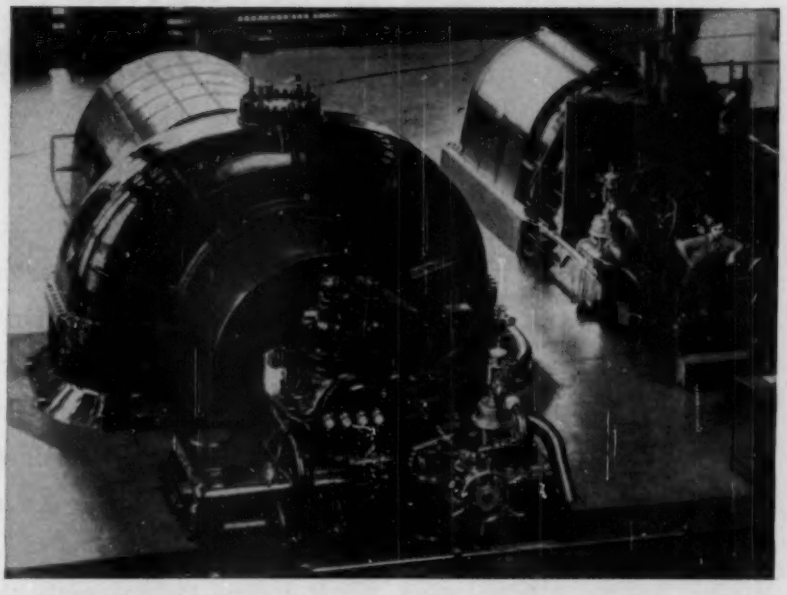
For technical information about all fluorosilicones, use coupon on this page or circle reference number 241 on reader service card

TURBINES:

Shell reveals three ways that Turbo Oils help prevent oil breakdown, rust, sludge and foaming

Small quantities of air and water can work their way into any turbine lubrication system. These contaminants can accelerate oxidation of the oil.

Read how Shell scientists developed a specific formulation that counters this oxidation and brings you turbine lubricating oils with top performance records.



Shell Turbo Oils lubricate turbines with total rating of more than 17 million kw in the U. S. and Canada.

WHEN oxygen attacks turbine oil, it can form peroxides and organic acids. A chain of oxidation reactions begins. If the oil stability is inadequate, sludge can form.

Air entrained in the oil can aggravate oxidation. And it may cause foaming.

The oil may also be affected by water in the system. Laboratory tests have shown that water can greatly accelerate an oxidation process.

With Shell Turbo® Oil, Shell tackles these problems in three key ways:

1. *Shell carefully selects base oils for use as turbine lubricants,* then refines them to get the most effective response to Shell's special additives.

2. *Shell adds a powerful oxidation inhibitor to its precisely refined base oils.* This inhibitor helps prevent the chain of oxidation reactions caused by oxygen exposure at operating temperatures. It helps keep the oil in good condition, and lengthens its service life.

The result is that Shell Turbo Oils have proved themselves unusually stable over long service periods.

3. *Shell uses an outstanding rust inhibitor.* As a protective measure, Shell uses special additives that cover metallic surfaces with strongly adherent polar-type films.

These films are designed to *help keep water from the metal surface.*

In drastically accelerated laboratory tests, metals immersed in Shell Turbo Oils show outstanding anti-rust performance—even in the presence of sea water.

Ask your Shell Industrial Products Representative for facts on Shell Turbo Oils. Or write: Shell Oil Company, 50 West 50th Street, New York 20, New York.

A message to manufacturers of turbine equipment

There are several grades of Shell Turbo Oil. One of them suits your equipment.

1. Your customers can get Shell Turbo Oils at Shell depots everywhere. Readily available throughout the world.

2. Quality is consistently high. Shell Turbo Oils always deliver top performance.

SHELL

A BULLETIN FROM SHELL
—where 1,997 scientists are working to provide better products for industry

Circle 264 on Page 19

Reliance develops first line of solid state regulators for variable speed drives

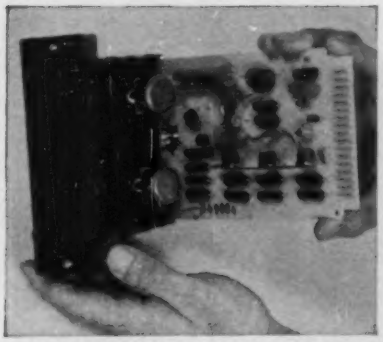
. . . gives you better circuits, precise control, less maintenance.

Reliance has produced the first complete line of solid state regulators and exciters for variable speed (V*S) drives and Engineered Drive Systems. These new devices, using power silicon rectifiers and diodes in place of tubes, achieve precise motor control, 1/10% regulation at base speed, with response times up to twice as fast as tube-type regulators. Here is a major advance in variable speed control, and a major advantage for the industrial user. Reliance Drives with these new regulators are now available to you in 1 to 1500 horsepower.

Reliance research and development brings you a more efficient drive than ever before . . . and a notable refinement of already well-engineered systems.

The pictures on the facing page tell the story.

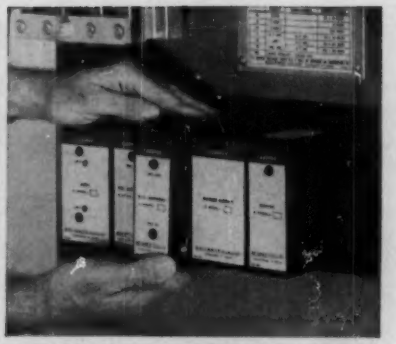
RELIANCE . . . builders of the tools of automation



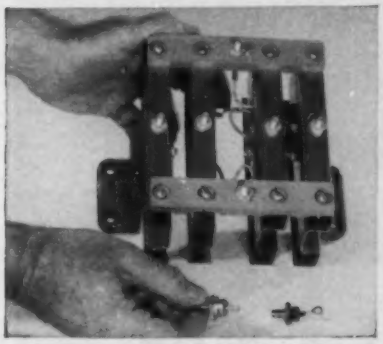
1. Heart of the system is new "Cardpak" control circuit, with transistors, capacitors and resistors to amplify feed-back signals.



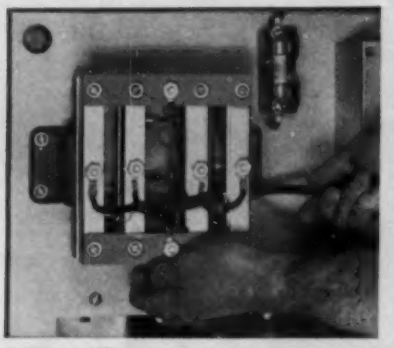
2. Each plug-in "Cardpak" module is a complete control circuit...can be quickly checked and easily replaced, if ever necessary.



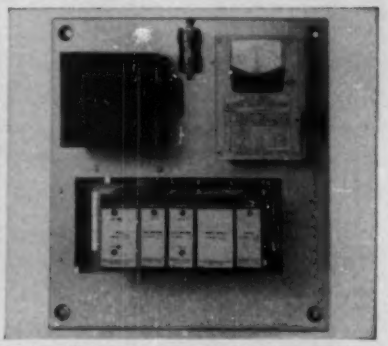
3. Each V★S Drive control system is tailored to your specific job . . . with "Cardpak "circuits pre-engineered for reliability, fast delivery.



4. Power silicon controlled rectifiers and diodes, instead of tubes, are among the most reliable components yet devised.



5. The rectifiers, mounted on copper plates for heat radiation, operate over a wide temperature range with no special cooling.



6. Complete panel can be checked quickly for start-up and trouble shooting with the optional test fixture . . . one meter, one knob.



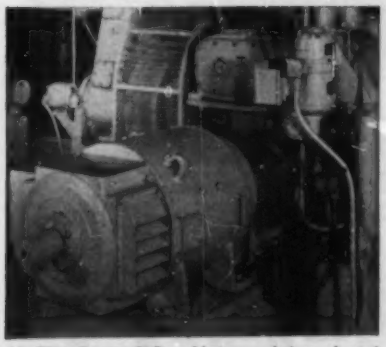
7. Motor control is precise . . . 1/10% regulation at base speed, with response times up to twice as fast as tube type regulators.



8. The Reliance V★S Drive control cabinet is 35% smaller than conventional drives. Cabinet can be located where convenient.



9. Operator's station centralizes drive operation. Multiple stations, bench boards, pendent stations and special controls available.



10. The Super-T D-c. Motor . . . integral part of the V★S Drive. It's rugged . . . absorbs repeated 100% overloads for one full minute.

Your nearest Reliance Systems Engineer will give you all the facts . . . help you apply Reliance V★S Drives to your products and processes. Call him through the Yellow Pages, or write us direct.

A-1889

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 28-11, CLEVELAND 17, OHIO • Canadian Division: Toronto, Ont.

Circle 265 on Page 19

ELIMINATE UNNECESSARY ASSEMBLY COSTS with



Replace improvised units with readily available precision cam followers.

McGILL®

CAMROL® BEARINGS

CF (Cam Follower) SERIES

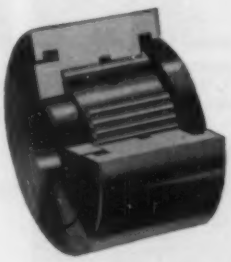
The original and still unsurpassed anti-friction roller bearing cam-follower bearing that adds efficiency at less cost to cam actuated, track and support roller applications. Built with full roller complement and integral stud, the CF series design provides high radial capacity and shock load protection in a compact roller with its own shaft. Easily applied and available in roller diameters of ½" to 4".

for the ultimate in:

- RADIAL CAPACITY
- SHOCK RESISTANCE
- SPACE ECONOMY

SCF SERIES.

Sealed to keep contamination out and lubricant in. It is dimensionally interchangeable with the CF bearings. A turned groove in the center of the outer raceway bore provides a permanent lubricant reservoir to approach life-time lubrication requirements. Can be easily re-lubricated.



SCYR SERIES (sealed)

CYR (Cam Yoke Roller) SERIES

The CYR series increases the adaptability of the CF bearing to all types of automatic machinery involving cam action or controlled-motion machine parts that require guide or support rollers. An inner ring replaces the stud for cam yoke roller mountings.

Write for McGill's Bearing Catalog No. 62, for engineering data with dimensional and capacity information on McGill needle type roller bearings. Ask about special precision ball and roller bearings.



SCYR SERIES

This series provides a fully sealed Cam Yoke Roller type bearing. It is dimensionally interchangeable with the CYR bearings.

engineered electrical products

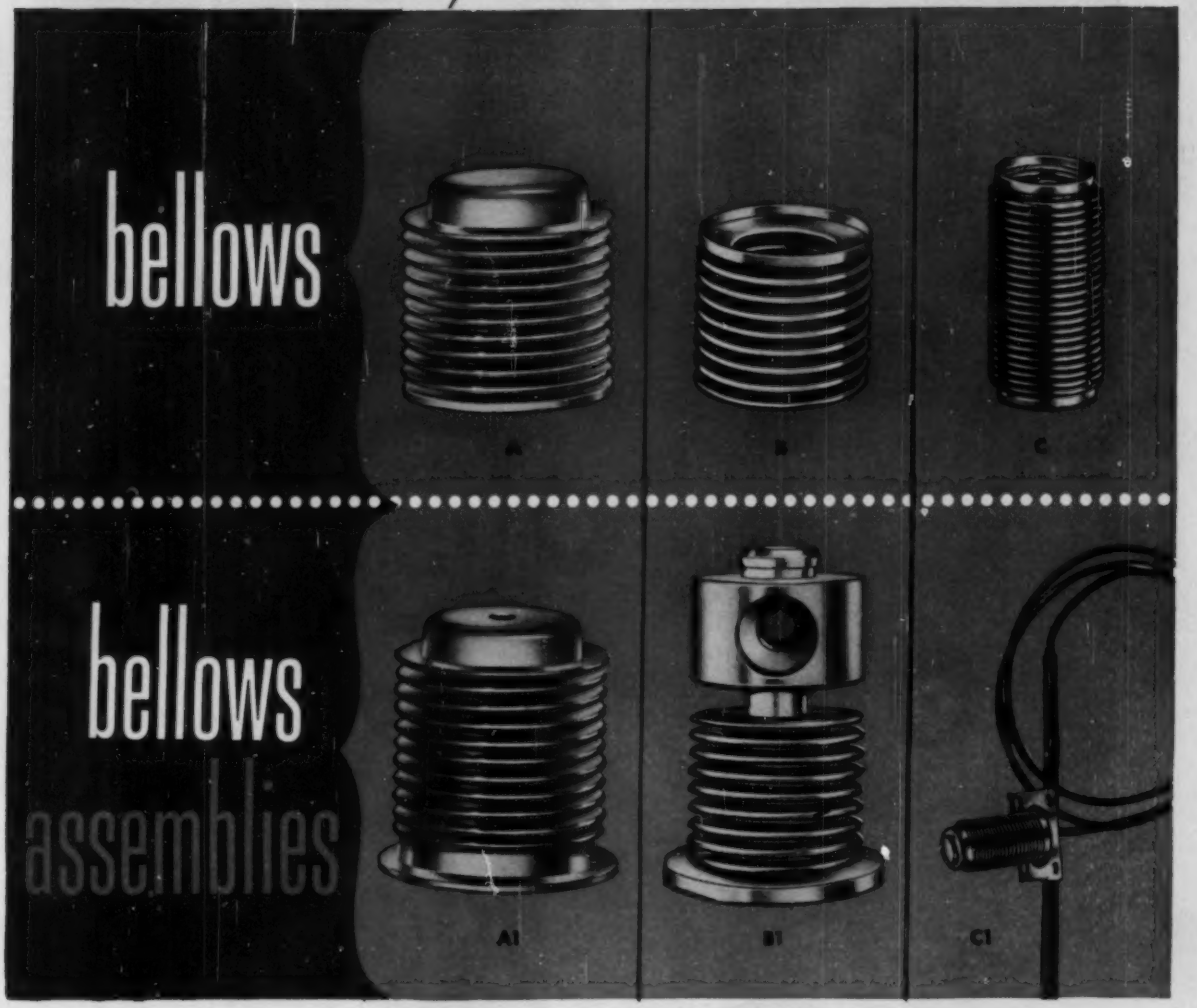
McGILL®

precision needle roller bearings

McGILL MANUFACTURING CO., INC., Bearing Division
200 N. Lafayette Street, Valparaiso, Indiana

Circle 266 on Page 19

Flexonics / YOUR MOST CAPABLE SOURCE...



Uniformity of effective area and spring rate . . . adaptability to a wide variety of fittings . . . a broad range of sizes and materials . . . and proved long cycle life. These are sound reasons why leading manufacturers specify Flexonics bellows for temperature and pressure measurement, shaft sealing, even transmitting low-torque rotary motion. Important, too, is that the majority of these companies rely on Flexonics to furnish the complete bellows assembly. They have learned that the delicate and intricate operation of applying fittings by circular resistance welding, inert arc welding, silver brazing and soft soldering can be more ably performed by Flexonics highly skilled technicians. Full responsibility is with one source. Call on your Flexonics bellows expert or write for Flexonics Design Guide Number 231.

B-545

Flexonics

DIVISION OF CALUMET & HECLA, INC.
350 East Devon Avenue • Bartlett, Illinois

FLEXIBLE METAL and SYNTHETIC HOSE
EXPANSION JOINTS
BELLOWS • SPECIAL TUBULAR ASSEMBLIES

In CANADA
FLEXONICS CORPORATION OF CANADA, LTD.
BRAMPTON, ONTARIO

ATTACH TO YOUR LETTERHEAD



FLEXONICS
350 East Devon Avenue
Bartlett, Illinois

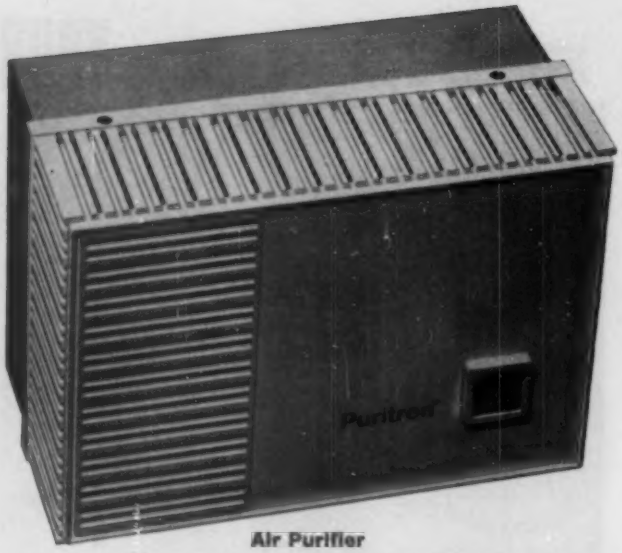
Please send my personal copy of Flexonics Bellows Design Guide No. 231, covering in detail Flexonics products and service for bellows application.

Circle 267 on Page 19



Trading Stamp Dispenser

Housing molded of IMPLEX for impact resistance, high gloss, durability under severe conditions of use.



Air Purifier

Housing molded of IMPLEX for excellent appearance, toughness, color stability, sales appeal.



Automatic Chemical Feeder

Housing, adjustment dial and 10 internal parts molded of IMPLEX for strength, stain resistance, surface hardness, ease of cleaning, dimensional stability.

High quality housings at moderate cost

Housings that match quality appearance with quality performance are just some of the host of parts in many fields that are now being molded of IMPLEX® acrylic plastic. You'll find the specific combination of properties *you* need in one of the five formulations of IMPLEX. Write today for full information on *tough . . . colorful . . . stain-resistant* IMPLEX.

ROHM & HAAS

PHILADELPHIA 5, PA.

In Canada: *Rohm & Haas Company of Canada, Ltd., West Hill, Ontario*

IMPLEX



An industry that produces and packages over 510 billion units a year obviously demands machinery of highly specialized capability.

This is the tobacco industry—and we at American Machine & Foundry Company are proud of our more than sixty years of leadership in developing the machines that help make this tremendous production possible.

But it occurs to us that these machines, with modification, may hold the solution to problems in many other industries, as well. A maker of a small packaged product, like a soap or a pharmaceutical, where accurate weight can mean the difference between profit and loss—or a manufacturer of a packed and cartoned product, may be interested in a packing machine that might be adapted to his product. A processor of a large, loose raw material may be interested in how AMF developed tobacco leaf handling and processing systems—and want to apply the same know-how to wasteful, uneconomic hand operations. The use of electronics in the control of high-speed inspection, correction and packaging may interest still another industry.

We, of course, do not know your particular problem. But our AMF research and development teams, involving highly skilled engineers, technicians and scientists throughout the world, may help you find the answer.

Tell us *your* problem. There is no obligation and your inquiry will be treated in strict confidence.

TOBACCO MACHINERY GROUP Dept. MD
AMERICAN MACHINE & FOUNDRY COMPANY
EXECUTIVE OFFICES: AMF Building, 261 Madison Avenue, New York 16, New York

AMF Bologna · Frankfurt · Geneva · London · Mexico City · Paris
San Juan · Sao Paulo · Stockholm · Sydney · Tokyo · Vienna

Circle 269 on Page 19



A full line of capacities from 10 to 52 points. Capable of millions of steps without adjustment.

Fast "Off-The-Shelf" delivery

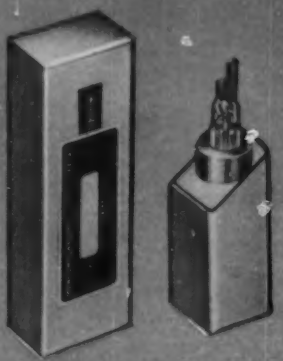
Overnight delivery on many items at factory prices

When standard CLARE relays or switches meet your needs, distributor service saves you time, costs you no more.

Top quality
—the same fine design and long life you get in CLARE custom-built relays and switches.

Easy purchasing
—you can order CLARE relays at the same time you purchase other components...have them delivered together.

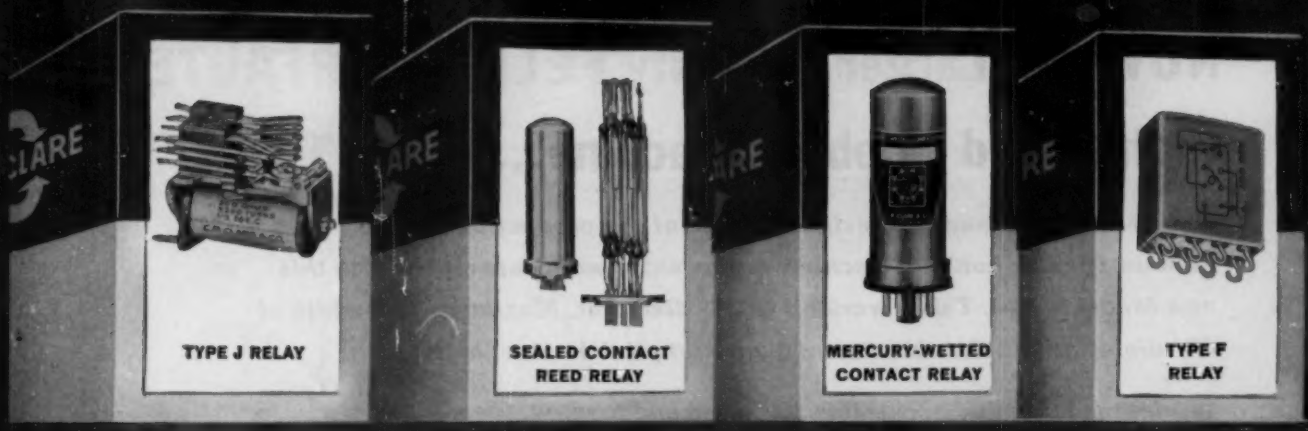
Engineering assistance
—always available from CLARE field engineers who work in close cooperation with CLARE distributors.



NOW AVAILABLE
...mercury-wetted contact relay modules for mounting on your own printed circuit board

Type HGM relay module (left) with cut-away (right) showing mercury-wetted switch capsule and coil potted in steel enclosure.

Your nearby CLARE distributor can now supply you with the new CLARE mercury-wetted relays, steel enclosed and ready for mounting. They combine the famous CLARE billion-operation reliability with unusual ease of handling and application. You can choose either the standard CLARE HG relay module or the HGS, super-fast and super-sensitive. Each module contains the CLARE mercury-wetted contact switch capsule with contacts continually wetted by capillary action. They never bounce, never get dirty, never weld and never wear out.



A compact telephone type relay of unequaled long life and superior performance.

A highly reliable switching device for single or multiple circuit control...wide mounting versatility.

Single or multiple switch capsules potted in steel container. Gives billions of operations with no maintenance.

A crystal can relay with unusual flexibility and a variety of mounting styles.

of top-quality Clare relays

From these distributors



PACIFIC COAST

1. **Puget Electro Products**
   5319 Fourth Ave., South
   Seattle 8, Washington
   Tel: Parkway 5-9700

2. **Bell Electronic Corporation**
   1070 O'Brien Drive
   Menlo Park, California
   Tel: Davenport 3-9431

2. **Bell Electronic Corporation**
   306 E. Alondra
   Gardena, California
   Tel: Faculty 1-5902

2. **Bell Electronic Corporation**
   8072 Engineers Road
   San Diego 12, California
   Tel: Browning 8-4360

SOUTHWEST

3. **Radio Specialties Co., Inc.**
   8323 Acoma Road, S.E.
   Albuquerque, New Mexico
   Tel. Amherst 8-3901

3. **Radio Specialties Co., Inc.**
   209 Penn Avenue
   Alamogordo, New Mexico
   Tel: Hemlock 7-0370

4. **Engineering Supply Co.**
   6000 Denton Drive
   Dallas 35, Texas
   Tel: Fleetwood 7-6121

5. **Harrison Equipment Co., Inc.**
   1422 San Jacinto St.
   P. O. Box 1505
   Houston 1, Texas
   Tel: Capitol 4-8131

6. **Engineering Supply Co.**
   1124 East Fourth Street
   Tulsa 20, Oklahoma
   Tel: Luther 3-6121

CENTRAL

10. **Relay Sales, Inc.**
    P. O. Box 189
    West Chicago, Illinois
    Tel: 231-1100

11. **Srepco, Inc.**
    314 Leo Street
    Dayton 4, Ohio
    Tel: Baldwin 6-2343

12. **Pioneer Electronics Supply Co.**
    5403 Prospect Avenue
    Cleveland 3, Ohio
    Tel: 432-0010

13. **M G Electronics & Equip. Co.**
    201-3 South 16th Street
    Birmingham 3, Alabama
    Tel: FA 2-0449

EAST

7. **R & D Supply, Inc.**
   1492 Highland Ave.
   Needham 92, Mass.
   Tel: Hillcrest 4-4500

8. **Avnet Electronics Corp.**
   70 State Street
   Westbury, L.I., New York
   Tel: Edgewood 3-5900

9. **Electronic Wholesalers, Inc.**
   1301 Hibiscus Boulevard
   P. O. Drawer 1655
   Melbourne, Florida
   Tel: PA 3-1441

9. **Electronic Wholesalers, Inc.**
   8390 N.W. 27th Ave.
   Miami 47, Florida
   Tel: Oxford 6-1620

C. P. Clare & Co., 3101 Pratt Blvd.,
Chicago 45, Illinois.
Cable Address: CLARELAY
In Canada: C. P. Clare Canada Limited
340 Caledonia Road, Toronto 19, Ontario.
In Europe: Europelec,
les Clayes-sous-Bois (S.et O.), France.

C. P. CLARE & CO.

Relays and related control components

Circle 270 on Page 19

NOW...A Larger Capacity FELLOWS-PFAUTER High-Speed Hobbing Machine...The P 630

You get all the advanced-design features of the production-proved P 400 Fellows-Pfauter hobbing machine — plus extra work capacity — with this new Model P 630. Takes work up to 25″ diameter. Maximum face width at 25″ diameter is 16¼″. Maximum diametral pitch in steel is 3.

Work area is readily accessible for setup and loading, and table retracts automatically from hob to facilitate work changes. Hob shifting is by push-button. It's solid too, with rugged hob head and double wall construction column and bed, and heavy V-ways. Table is as large as maximum workpiece diameter — work column of massive design.



Reduce your production costs with this new Fellows-Pfauter. Write for details.



NEW... Dictionary of Change-Gear Combinations

"Fellows-Pfauter Change Gear Tables" by F. Becher and A. Koerner eliminates tedious calculations and trial-and-error methods. Gives combinations for more than 26,000 ratios carried to six decimal places from .100,000 to 1.000,000, with greatest step approximately .00005. Gears in range of 18 to 80 teeth mainly used. Examples are given. Only $8.00. Order from THE FELLOWS GEAR SHAPER COMPANY, 78 River St., Springfield, Vermont, U.S.A.

THE FELLOWS GEAR SHAPER COMPANY
78 River Street, Springfield, Vermont, U.S.A.

Branch Offices:
1048 North Woodward Ave., Royal Oak, Mich.
150 West Pleasant Ave., Maywood, N. J.
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THE PRECISION LINE

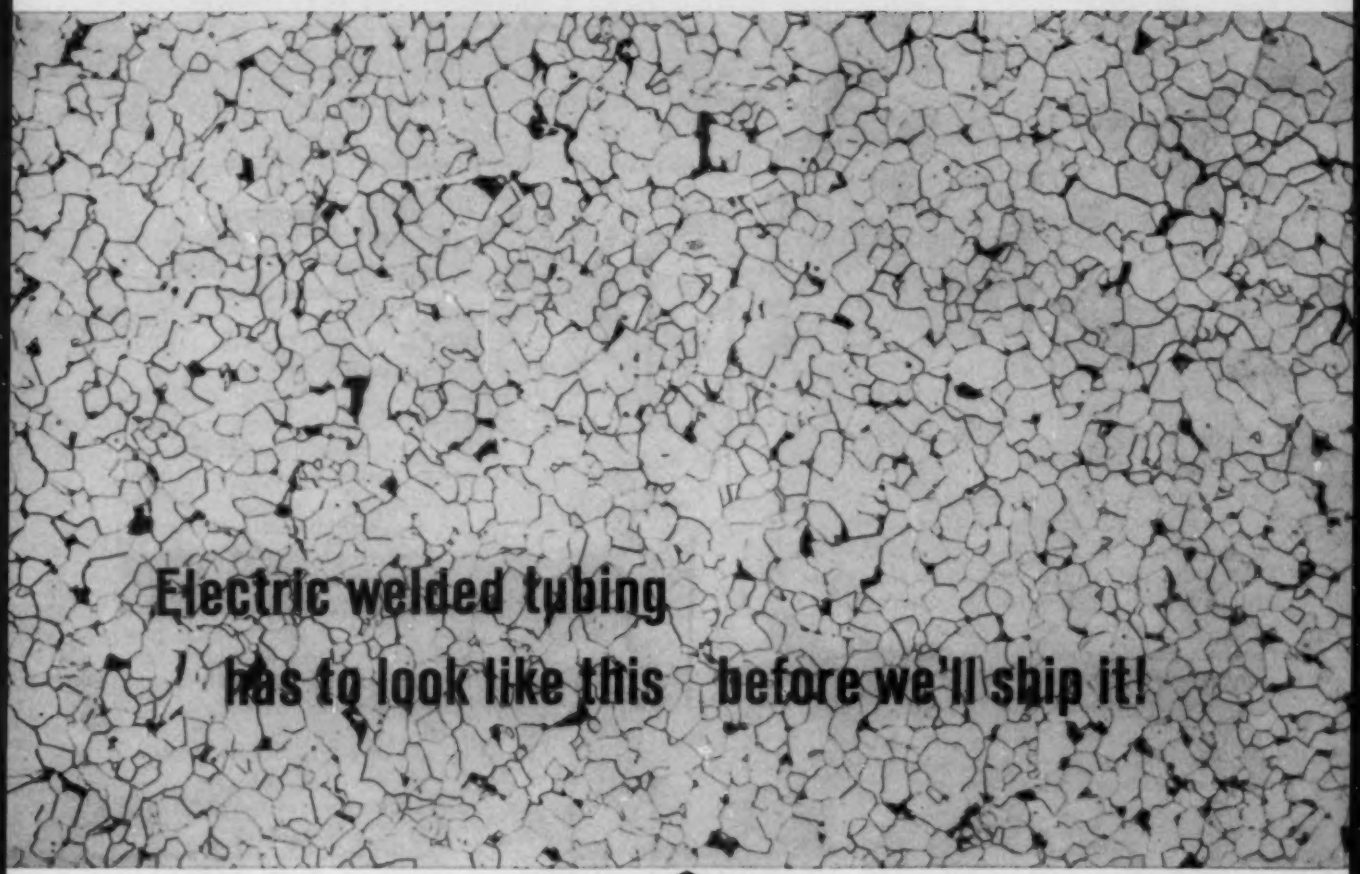
Fellows

Gear Production Equipment

This mark tells you a product is made of modern, dependable Steel.

Portrait of a perfect weld

Magnification—100X; Etch-Picral Nital



In this photomicrograph of a section of USS National Electric Resistance Welded Steel Mechanical Tubing the weld section runs right down through the center of the picture above the arrow. The consistency of structure between the weld area and the rest of the tube shows that USS National Welded Mechanical Tubing has an important attribute—dependability.

Mechanical tubing must be flawless. It's used in so many critical applications that demand utmost strength, excellent surface inside or outside and extreme dimensional accuracy. National Tube's production methods assure this high quality.

Important advantages of USS National Welded Mechanical Tubing are its ability to reduce machining operations to a minimum or eliminate them entirely. For a given weight, it withstands more load than any other section. It resists bending stresses equally in all directions. In torsion, it provides maximum material distribution.

USS National Welded Mechanical Tubing is available in cold-drawn or hot-rolled sizes ⅜″ thru 5½″ and in wall thickness .035″ to .250″. All sizes can be obtained from National Tube Distributors located throughout the country. They will gladly show how tubing can reduce your costs. *See your USS National Tube Distributor.* *USS and National are registered trademarks*

National Tube Division of United States Steel

USS

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • United States Steel Supply Division • United States Steel Export Company, New York

Circle 272 on Page 19

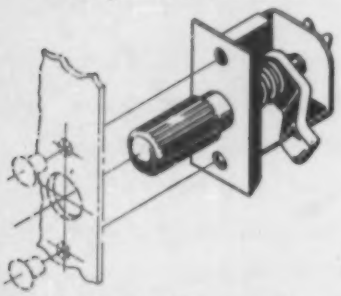
It's a good design, but

how will you fasten that panel?

Design a package that no standard fastener will fit, and you'll need a special device. We design and build specials. But standards (like those shown here) cost less and get there sooner.

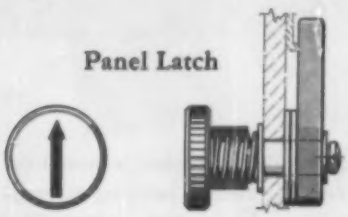
56 pages of standard fasteners in our new Handbook No. 11.* Send for one... it's free. Write Southco, 237 Industrial Highway, Lester, Pa.

Adjustable Fastener



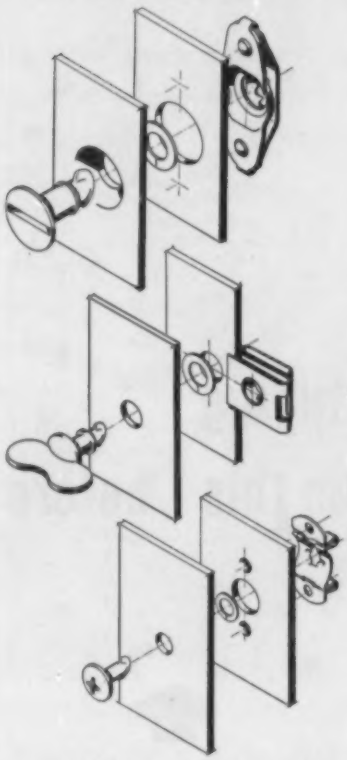
Best Application: To compress a gasket, resist vibration, fit varying frame thicknesses.
Form: One piece latch installed by passing knob through door. Quarter turn opens or closes. No striker required.
Features: Further turning of knob changes grip to hold different frame thicknesses, tightens door against gasket.
Availability: From stock in 4 sizes, miniature to large. *Handbook pp. 28-37.

Panel Latch



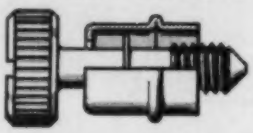
Best Application: Where spring loading, single hole mounting, and minimum inside clearance are factors.
Form: Chromed knob with arrowhead to indicate pawl position. Spring in plated ferrule applies tension to pawl.
Features: Uses only 3/16" inside space. Pushing knob relaxes operating tension.
Availability: From stock, individually packaged. *Handbook pg. 43. Other latches, pp. 38-43.

Lion 1/4 Turn Fastener



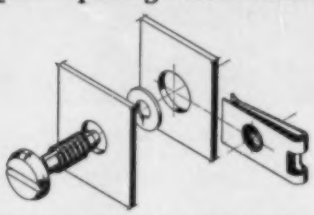
Best Application: For light weight, quick operation, vibration resistance. To meet Mil Spec. MIL-F-5591A (ASG).
Form: Swaged nose stud, retainer (to captivate stud), solid leaf receptacle.
Features: Quarter-turn clockwise locks, quarter-turn counterclockwise unlocks. One piece stud design adds considerable strength. Clip-on receptacle speeds installation.
Availability: From stock in variety of head styles. Ten receptacles offered over the three sizes, including side-mount and casting mount. *Handbook pp. 9-18.

Retractable Screw Fastener



Best Application: Drawers, slides, doors, especially on electronic equipment.
Form: Polished stainless steel screw retained in standoff flanged into door. Screw engages tapped hole in frame.
Features: Screws can be used in multiples, operated individually without forcing door. Float of screw in standoff tolerates misalignment.
Availability: From stock in 5 head sizes (slotted or unslotted), 8 thread sizes from 1/4-20 to 4-40. Spring loading for automatic retraction also from stock. *Handbook pp. 18-22.

Quick-opening Screw Fastener



Best Application: Where misalignment is present, or where doors may be subject to hard use or deformation.
Form: Heavy square-threaded screw assembly held in outer panel by retainer and engaging receptacle on frame.
Features: Maximum float for ease of installation and alignment. One assembly fits variety of door and frame thicknesses.
Availability: From stock in Nos. 2 and 7 sizes. Three head styles; riveted, welded, clip-on receptacles. *Handbook pp. 23-27.

SOUTHCO FASTENERS
LION

©1961

FALK

A GOOD NAME IN INDUSTRY



FALK STEELFLEX COUPLINGS
for industrial applications...large or small

Giant Falk Coupling smooths out steel blooming mill performance

On a blooming mill at the Copperweld Steel Company plant in Warren, Ohio, installation of a large Falk Steelflex coupling between motor and pinion stand eliminated troublesome noise and vibration which threatened to damage mill machinery. Transmitting 5,000 hp at 50/100 rpm, this is not the largest Falk coupling... others are designed to transmit up to 130,000 hp at 100 rpm.

This installation and others like it prove the Falk concept of shaft coupling design—namely, a modern shaft coupling must contribute to the successful performance of the machinery system.

What does this mean to you? Just this: On large machines as well as small, the exclusive Falk grid-groove design does make a difference, and the difference is torsional resiliency with the strength of steel...reason enough to specify Falk Steelflex couplings as "long life" insurance for your connected machinery.

Falk Steelflex couplings are available in standard designs in 34 sizes for applications from .3 hp at 100 rpm to 130,000 hp at 100 rpm, with excellent delivery. Write for Bulletin 4100.

THE FALK CORPORATION, MILWAUKEE 1, WISCONSIN

MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

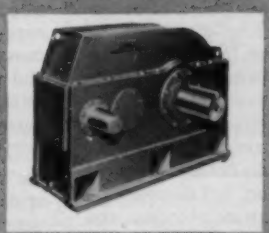
Representatives and Distributors in most principal cities

• • •

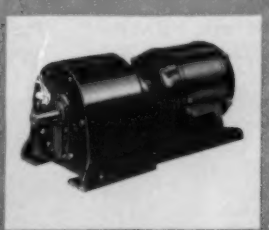
A Point to Ponder... When you need gear drives or shaft couplings of "FALK OR EQUAL" quality, where but from Falk can you get the "OR EQUAL"?

Circle 274 on Page 19

Other members of America's First Family of Power Transmission Products



SPEED REDUCERS
Parallel Shaft up to 3500 hp. Ask for Bulletin 1100. Also Right Angle and Concentric Shaft designs.



ALL-STEEL MOTOREDUCERS
—up to 75 hp. Horizontal, Vertical, and Right Angle. All-Motor and Integral Types. Ask for Bulletin 3100.



SHAFT MOUNTED DRIVES
—up to 125 hp. Ask for Bulletin 7100. Also Flange Mounted and Screw Conveyor Drives.

FALK, STEELFLEX and ALL-MOTOR are registered trademarks

Designers think of R/M first for asbestos, rubber,



Solves major operating problems for tire press manufacturer with new Teflon*-impregnated molded asbestos piston cups

New molded asbestos piston cups impregnated with Teflon, developed by Raybestos-Manhattan, Inc., have enabled National Rubber Machinery Company, Akron, Ohio, to improve the economy and efficiency of its Autoform Slideback Tire Press while realizing substantial savings. The new seal has not only reduced air loss to a minimum, but eliminated a lubrication system, cut maintenance, and increased machine operating life.

Before adopting R/M cups, NRM used metal rings for the ram and cylinder assembly. These did not provide the seal required, permitted a 5 to 10% air loss, caused excessive wear on moving parts, and required lubricants which were entrained, seeped into the molds, and damaged the tire rubber.

In considering a suitable replacement for the metal rings, NRM tested various synthetic rubber and leather cups. All deteriorated rapidly in temperatures up to 380°F. Then R/M was consulted. Preliminary investigation indicated asbestos with a Teflon filler as a potentially good combination for this application. Nearly a year of research, testing and engineering collaboration followed. Samples were developed and tested in the field under actual operating conditions. Only when all results were in—after two years—did NRM adopt R/M cups for use in all its presses.

R/M's experience in the manufacture of packings, gasket materials, and specialty products to meet the exacting and varied requirements of industry is at your disposal—whatever your need call on R/M.



The application of R/M piston cups provided two important benefits. It eliminated oil in the curing room, preventing damage to the tire rubber. It reduced air loss with properly fitted and installed cups.

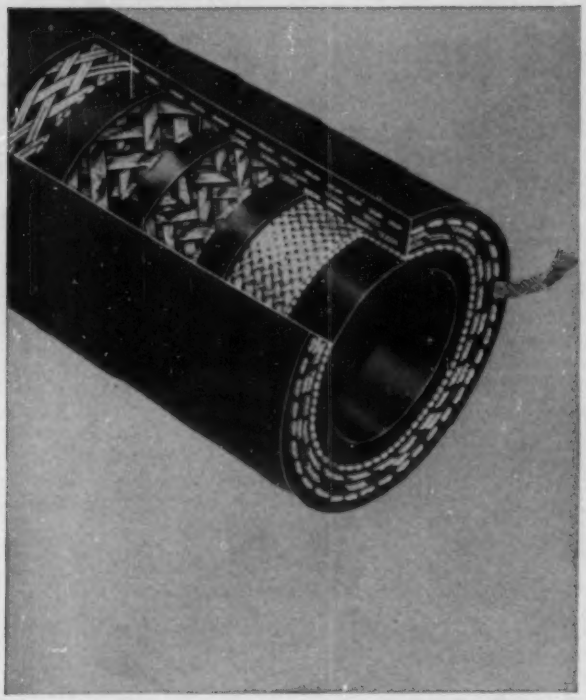
Registered trademark for Du Pont fluorocarbon resins

PACKINGS



For complete information on R/M Molded Piston Cups and other R/M packings and gasket materials, write for new Catalog P-100. Packing Division, Raybestos-Manhattan, Inc., Passaic, N.J.

sintered metal, and engineered plastic products



Non-burst Rubber Steam Hose

Strength of steel, heat resistance of asbestos, flexibility of rubber

For saturated steam pressures to 200 lbs., 388°F. Strength and durability are employed throughout the construction of Super-Master BW Steam Hose, illustrated above. Braids of high-tensile, non-corrosive steel wire are applied at a controlled angle over an asbestos-covered steam-resistant rubber tube for greatest strength with minimum elongation and contraction, and provide positive protection against bursting. Special Butyl rubber cover resists heat and weather, has static dissipating wire. The safest high-pressure steam hose made. Write for Bulletin M630.

Rubber hose for every purpose—air, oil, suction, Teflon hose for corrosive chemicals, flexible rubber pipe and expansion joints for abrasion and vibration... outlasts steel pipe. Write for Catalog M5.

RUBBER



Write today for free booklet shown: full details on a wide variety of industrial rubber products. Manhattan Rubber Division, Raybestos-Manhattan, Inc., Passaic, N. J.

BOND FAILURES CAN BE PREVENTED!

Here's how to stop 13 of them . . .

Type of Failure	Solution
THERMOSETTING ADHESIVES	
• Cohesive failure	Check film with solvent used in adhesive. If solvent softens the adhesive film or becomes tacky, this indicates insufficient cure. Make sure bond line time and temperature is used.
• Adhesive failure from metal	If metal surface has a white, clean appearance, check cleaning technique.
• Adhesive failure from substrate other than metal	Try prime coat of diluted adhesive, also check compatibility.
• Cellular areas in adhesive line	Increase pressure and/or adhesive.
CONTACT ADHESIVES —room temperature setting	
• Tacky film	If film should dry hard but remains tacky, the cause may be entrapped solvent or migration of plasticizer from one substrate.
• Shiny areas	Poor contact, insufficient pressure or insufficient amount of cement.
• No bond	If heat reactivated type, adhesive was too cool at time of assembly or poor compatibility.
• Failure in adhesive from metal	Improper cleaning.
• From substrate other than metal	Incompatible or unclean surfaces.
HOT MELT	
• No bond	Incompatibility, adhesive too cool at time of assembly. Parts too cool at time of application of adhesive.
EPOXY BASE ADHESIVES AND CASTING COMPOUNDS	
• High exotherm	Mix lower volume and pour mixed material into shallow tray. Cool base and activator before mixing or use Metermixing equipment.
• Tacky film or casting	Improper base activator ratio, improper mixing of base and activator, improper cure. Check bond line temperature.
• Flexible casting or film of rigid adhesive or casting compound	Improper mixing of base and activator, improper base and activator, improper cure. Check bond line temperature.

Bond failures can be prevented! Raybestos-Manhattan's adhesive experts also have solutions to less common causes of bond failures . . . based on more than 20 years' experience in the production of bonded assemblies and the manufacture of adhesives, coatings and sealers. Why not call on them today for the answers to your adhesive problems—no cost or obligation, naturally.

ADHESIVES



Get helpful engineering information on selecting, bonding and testing adhesives. Write today for your free copy of Bulletin No. 701. Adhesives Department, Raybestos-Manhattan, Inc., Bridgeport, Conn.

RAYBESTOS-MANHATTAN, INC.

FACTORIES: Passaic, N.J. • Bridgeport, Conn. • Manheim, Pa. • Paramount, Calif. • No. Charleston, S.C. Crawfordsville, Ind. • Neenah, Wis. • Peterborough, Ontario, Canada

RM

Circle 276 on Page 19 ▲

Circle 277 on Page 19 ▲

How to get a pump and motor into the smallest possible space

by E. H. Schanzlin
Chief Engineer, Tuthill Pump Company

Today's designer faces stringent limitations on space and weight in more and more of his assignments. Miniaturization is the order of the day. Even if we exclude rockets, missiles, aircraft and similar applications, reducing the size and weight of pump and motor combinations can result in significant savings.

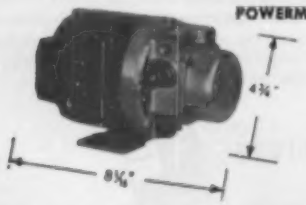
Compactness simplifies assembly operations . . . lowers production costs. Reduced weight means lower shipping expense. Elimination of components such as couplings, bases and adapters can mean substantial savings. And often a compact unit can provide the only feasible answer to a tough design problem.

Special Combinations Developed

Five years ago, Tuthill's engineering department initiated a special program to develop compact pump and motor combinations to provide the greatest possible savings in space and weight. The units on this page, plus others in our stock and on the drawing boards, are a result of this intensive and continuing program.

Powermite for OEM

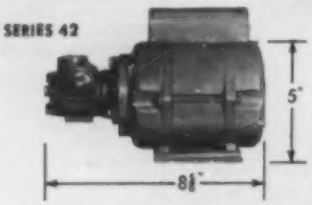
For original equipment applications involving substantial quantities, Tuthill's engineers have developed a special design in which the pump and motor are combined in one unit which takes up no more space and



weighs no more than a standard electric motor. The typical Powermite above, used in a hydraulic application, has a capacity of 16 gph at 350 psi despite its small size. Each Powermite is specially designed to meet the exact requirements of a specific OEM application.

Standard Units from Stock

In addition, Tuthill provides a wide selection of standard combinations immediately available from stock. Unlike the Powermite, the stock combinations can be furnished in single units, or any desired quantity.



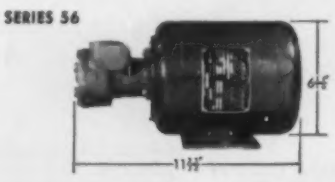
Here is a typical combination . . . series 42 totally enclosed ball bearing motors supplied with ratings from 1/12 to 1/6 hp, in combination with pumps with capacities of 20 to 45 gph at pressures to 200 psi.

Series 48 Combinations

A selection of series 48 combinations are normally supplied with totally enclosed fan-cooled motors of either split phase, capacitor or 3 phase construction, with ratings from ¼ to ½ hp. Pumps supplied in these combinations range from 20 gph to 360 gph at pressures to 360 psi. A typical combination measures only 7⅝" x 10⁷⁄₁₆".

Series 56 Units Available

Series 56 units measure 6¹¹⁄₁₆" x 11²³⁄₃₂" as shown. They are offered in a complete range of motors from ¼ to 1 hp . . . which can be coupled



with pumps with capacities from 20 to 360 gph at pressures to 500 psi.

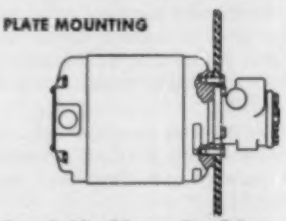
Many Others Available

Many other pump and motor combinations are available with capacities up to 50 gpm and for pressures to 500 psi. A new selection of closed coupled units will soon be offered with motor ratings to 5 hp.

Motors are normally furnished for 1725 rpm. However, they are usually available for 3450 and 1140 rpm as well. Explosion proof construction and double shaft extensions on motors are also furnished. Built-in relief valves and other modifications are optional.

Special Flange for Plate Mounting

For many applications a special mounting for close-coupled pump-motor combinations offers distinct advantages. Shown below, it allows the pump and motor to be mounted on any plate of sufficient thickness to bear the weight of the unit, by simply cutting a circular hole of sufficient size to allow the passage of the pump. It is particularly convenient for mounting on tanks, where it greatly simplifies piping arrangements. Through elimination of mounting flanges it further reduces space and weight.



Send Us Your Problem

In addition to these, Tuthill has developed a wide range of solutions to special problems involving pump-motor combinations. If you are trying to fit a pump and motor into a small space, take advantage of our experience. Write and give us the details.

Tuthill manufactures a complete line of positive displacement rotary pumps in capacities from 1/3 to 200 gpm; for pressures to 1500 psi; speeds to 3600 rpm.

PUMPS FOR YOUR PURPOSE
TUTHILL PUMP COMPANY
953 East 95th Street, Chicago 19, Illinois

Circle 278 on Page 19
Circle 279 on Page 19 →



EXOTIC STEELS FROM STANDARD

Official USAF photo

Space-Age forgings and rings to meet the most severe conditions of temperature environment and stress? Talk to Standard. We have been known in the trade for more than a century and a half as tops in quality and service. Tie *your* requirements to the experts on "can't be done" requirements.

Electric furnace, vacuum degassed steel, vacuum remelted alloys, aluminum and titanium forgings for rockets and missiles—produced under the most modern technical controls—as the trade has learned to know, that's the "specialty of the house" at Standard.



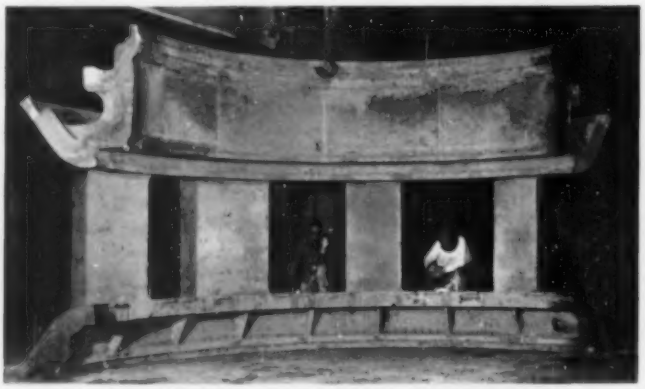


QUALITY CONTROL IS SECOND TO NONE AT STANDARD. Quality control at Standard is maintained by the most accurate, up-to-date testing equipment available. Laboratory facilities operate day and night to support our metallurgists, shop foremen, mill and machine operators—as well as plant management and, of course, our customers.

STANDARD'S OPEN-DIE FORGINGS SUPPLY NATION'S LEADING INDUSTRIES. Steel and nonferrous alloys can be worked in Standard's forge shop, including some hard-to-work metals such as titanium and super alloys. It can turn out forgings from 15 to 52,000 lb.; up to 45 inches in diameter; and up to 60 ft. in length. Major products include rotors and wheels for turbines, propeller shafts for ships, rolls for sugar, printing and rubber industries.

Standard's hundreds of customers represent every major industry in the world. Metal components of carbon and alloy steels, super alloys, and nonferrous alloys such as aluminum and titanium are supplied by Standard for an endless line of products. What particularly impresses our customers however, is the unique, personalized service we provide. See for yourself—bring your next problem to Standard.





STEEL CASTINGS TO VIRTUALLY ANY SPECIFICATIONS. The Standard foundry, one of the larger ones in the country, has turned out castings as light as 1 lb., and ranging up to 85,000 lb. They include some of the largest heads ever cast for dredge cutters and also vital components in huge hydroelectric projects throughout the world. Standard yields to none in the skill of its foundry engineers, metallurgists, molders, coremakers and core setters.

PIONEERS IN ROLL-FORGED RINGS . . . STANDARD. Standard's craftsmanship in forming metal rings for heavy industry dates back to 1856. The first all-forged weldless rings were produced in volume for the first time in 1870—at Standard. And much of the development work in forging weldless rings of high-alloy steels, aluminum and titanium has been done in Standard's Ring Department.

Standard Steel Works Division

BALDWIN · LIMA · HAMILTON

BURNHAM, PENNSYLVANIA

Rings • Shafts • Car wheels • Gear blanks • Flanges • Special shapes

BALDWIN BLH LIMA-HAMILTON

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MI-61-3

Some Ideas

for your file of practical information on drafting and reproduction from

KEUFFEL & ESSER CO.

Frankly, we hope you're a fusspot. If you are fussy about the way you work, and proud of it, we think you'll enjoy knowing about these K&E items . . .

A Real "Clinging Vine"

Some of our more meticulous K&E people have been known to walk out of a drafting room in a cold sweat at the way the drafting boards were covered. Its those ripples, wrinkles and bends that cause all the anxiety. "How," mutters our loyal agent, "can you expect to draw a straight line on a wavy surface?"

And its all so easy if you just take the right K&E product and mount it in the right way. The product in this case is LAMINENE® N70 Board Surface Material. This is a product *unique* with K&E. We hold a patent on the process that *laminates* a thin acetate film to a tough paper base – quite a bit different than simply *coating* a paper with plastic. And the results are different too.

It's rather a dramatic show of force that LAMINENE stages on a board. The secret is in the irresistible urge of a natural product to return to its normal state. In this case, when you *wet* the back of LAMINENE you expand it ever so slightly. When tacked or taped under the edges of the board, it begins to dry and shrink. The paper backing builds tension on the surface as it dries, finally reaching a smooth taut state . . . with enough tension left over to keep it permanently wrinkle-free. No matter what the temperature or humidity, LAMINENE stays with the board as if cemented there.

Add to this a fine, springy quality, and a variety of other features – grid lines, green color, washability – and you can see why LAMINENE rates at the top in popularity for a semi-permanent board covering.

Would you like a sample? It's yours for the asking. See your K&E dealer or return the coupon at the right.

Time Saving Stickers

Want to eliminate a time-consuming chore? You can cut down on tedious repetitive lettering by having title blocks, specifications, and other symbols or legends printed – clearly and sharply – on DULSEAL™ (74). This tissue-thin film has a delayed-action adhesive on the back, and a dull-finish face for easy writing or printing.



Stickers made of DULSEAL can be firmly positioned–and re-positioned hours later, just as firmly. The adhesive takes 24 hours to set. Once it does set, a permanent bond is formed with the paper or cloth beneath. DULSEAL is chemically stable, and the adhesive will not bleed, even in hot copying machines.

Repeated erasures on DULSEAL will not affect its "take." Produced by an exclusive process, the "tooth" is *built into* the surface. Transparent and low in reflectivity, DULSEAL stickers will not affect the transparency or printing speed of your drafting medium. K&E supplies DULSEAL in sheets, rolls (printed to your specifications if you wish), and as a mending tape in a handy dispenser. Try a sample, on us!

3 To Keep Clean

Best way to keep your tracings clean: don't let them get dirty. A mighty easy way to achieve this is to sprinkle the tracing lightly with gum eraser particles, while working. Then, triangles, T-squares, and scales stay clean, and clean the surface *automatically*, as they are moved back and forth. The particles will not dry out or harden – they contain no grit or abrasives. They'll actually improve the ink taking qualities of your drafting surface.



For this purpose, K&E supplies cleaning particles put up in three different ways. We think the new plastic squeeze-bottle (3036C) is the handiest of all. The shaker-top can (3036) has also been a drafting-room favorite for some time. And, for double-duty cleaning, we suggest the ABC DRY-CLEAN PAD™ (3037) or DRY-CLEAN JR.™ (3037J)–a smaller version–which hold slightly coarser granules that sift through soft mesh. The ABC Pad also comes in handy for wiping a complete tracing after it is finished, or for preparing certain surfaces for ink work. Or for an overall pre-cleaning, since the best way to insure clean tracings is never to let soil build up.

The proverbial ounce of prevention is worth the traditional pound of cure!

These K&E products, and others that can make life easier for you, are available from your nearby K&E dealer. See him soon . . . or send us the coupon below for further information and samples.



KEUFFEL & ESSER CO., Dept. MD-11, Hoboken, N. J.

Please send me samples and information on LAMINENE® Drawing Board Surface Material, and DULSEAL™ Tape . . . plus information on K&E cleaning powders.

Name & Title_____

Company & Address_____

_____

4259-B

← Circle 279 on Page 19

Circle 280 on Page 19

[Advertisement]

Performance, application and operating characteristics of new 2500 psi hydraulic vane pumps

By: Robert A. Manogue
Pumps/Controls Product Manager
Denison Engineering Division
American Brake Shoe Co.

In designing hydraulic circuits, it is normal to limit line velocities to a maximum of from 15 to 20 feet per second. This permits the use of the smallest practical lines, valves and fittings. Pressure drop in transmitting the fluid is thus dependent on flow velocity, number of valves and fittings and line length. For example, if the pressure drop of a given system is 50 psi, it represents a loss in transmission of 5% for a 1000 psi system and a loss of only 2% for a 2500 psi system. Power loss in transmission is reduced 60% by using 2500 psi components.

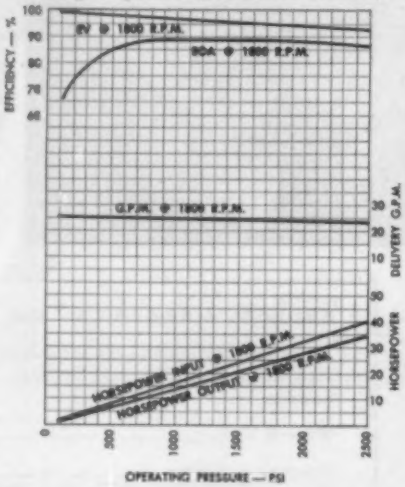
Net advantage is a more efficient hydraulic system with lighter weight and less cost-per-horsepower in smaller, more easily installed components than is possible with comparable lower pressure systems.

PERFORMANCE CHARACTERISTICS

Based on these inherent advantages for 2500 psi, Denison has engineered and produced a new series of "T1C" vane pumps with rated deliveries of 8, 11, 14 and 17 gpm at 1200 rpm and zero psi. Major considerations in designing the new pump were: Higher efficiency, speed and pressure for continuous duty to 2500 psi and 2500 rpm—as well as lower cost, ease of maintenance and compactness. The T1C pump shaft will support a radial load of 479 pounds at the center of the keyway.

PUMP CONSTRUCTION

The pump is a "cartridge" type design for quick, convenient servicing. It consists of a housing which provides an inlet connection, a bore for support of the shaft bearing and shaft assembly. The lip-type shaft seal is located outboard of the front bearing in the housing to permit bearing lubrication, using the fluid being pumped. A larger bore contains a floating front port plate, spring-loaded against the cam ring. The port plate is positioned radially by a dowel pin between the housing and port plate. The cam ring is located in a close-fitting bore and positioned radially by a dowel pin between the end cap and cam ring. Besides retaining the cam ring in the housing, the end cap contains suction and pressure cores and the outlet connection.



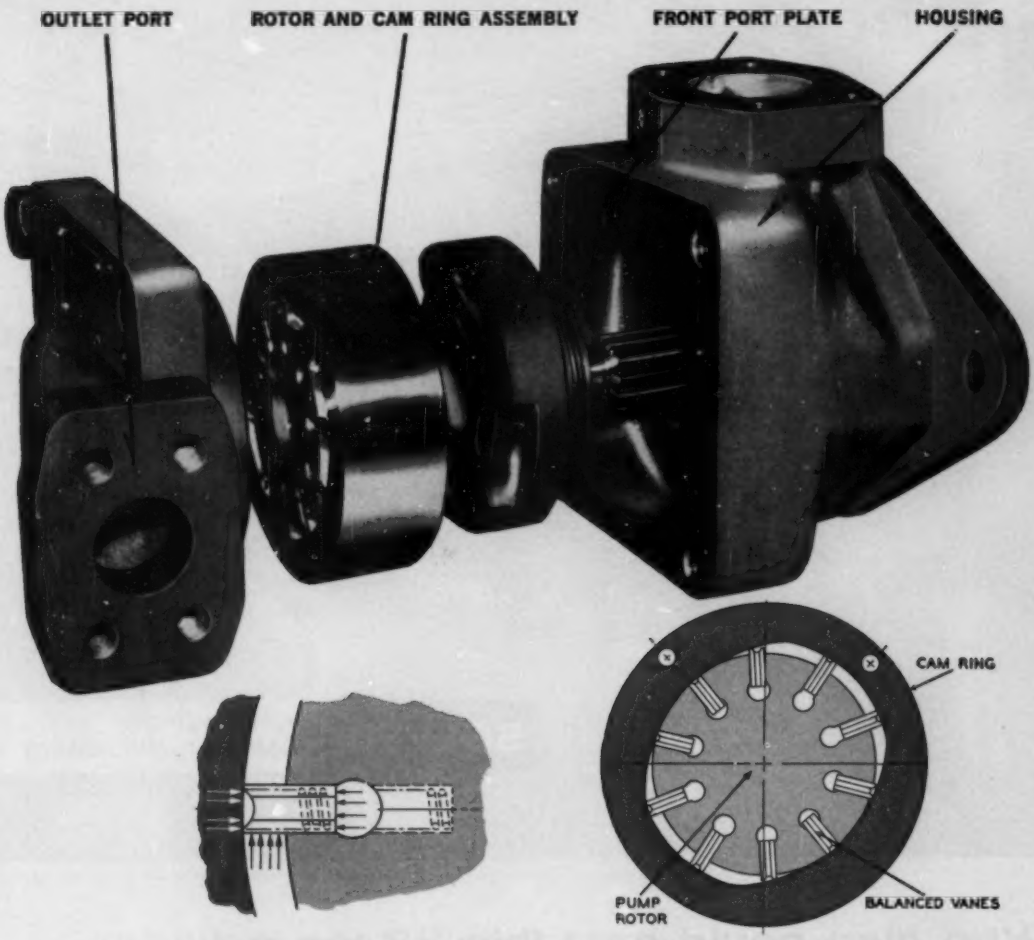
PERFORMANCE CURVES *demonstrate high volumetric efficiency of new 2500 psi Denison vane-type hydraulic pumps.*

To simplify piping, the end cap can be rotated to any one of four positions. The port pads on the pump match the four-bolt SAE port pads. An SAE "B" size mounting flange is provided on the standard pump. An alternate SAE splined shaft is available.

OPERATING CHARACTERISTICS

In operation, oil enters the pumping cavity through cast ports in the port plate and end cap. Oil is carried around to the discharge ports in the end cap and out the outlet port. The pump is internally drained at all times. The end cap contains a cored passage behind the bearing which allows a flow of oil through the bearing back to suction, keeping the bearing cool and minimizing wear.

A unique feature of the T1C pump is the floating front port plate which is free to move axially within limits. It utilizes hydraulic pressure to counteract internal hydraulic pressure that tends to separate the elements of the pumping cartridge after the pump is primed and delivering pressure to the circuit. A light spring



BALANCED OPEN-END VANE DESIGN *assures low wear through continuous pressure balancing which relieves hydraulic bearing loads between vanes and cam ring.*

ROTOR AND CAM RING ASSEMBLY *with large inlet ports for improved suction characteristics. Rotor is balanced axially and radially for consistently high volumetric efficiency and long life.*

is used to hold the pumping cartridge together when there is no pressure in the system and for starting. The floating plate construction minimizes scoring the wear faces on the front port plate and the end cap.

Oil flow in the pump is always from the inlet in the housing to the outlet in the end cap. Shaft rotation may be changed by simply repositioning the cam ring. Arrows indicate desired direction of rotation. The pump can be either flange or bracket mounted.

Other characteristics include: Oil, 150-300 SSU @ 100°F. Viscosity index, 90 or above. Minimum running viscosity, 65 SSU. Maximum viscosity at starting temperature, 7500 SSU. Data was determined with petroleum base oils.

APPLICATIONS

Among particularly suitable applications for new T1C pumps are: Mobile equipment—including earth-moving units, trucks, buses, tractors and power shovels where 2500 psi power can mean lower weight, increased payloads and greater user operating profit. Special machinery—including extrusion presses where the compact pump puts more power into less space. Automated production equipment—where feed circuits and index mechanisms benefit through the increased operating efficiency and low maintenance of 2500 psi hydraulics.

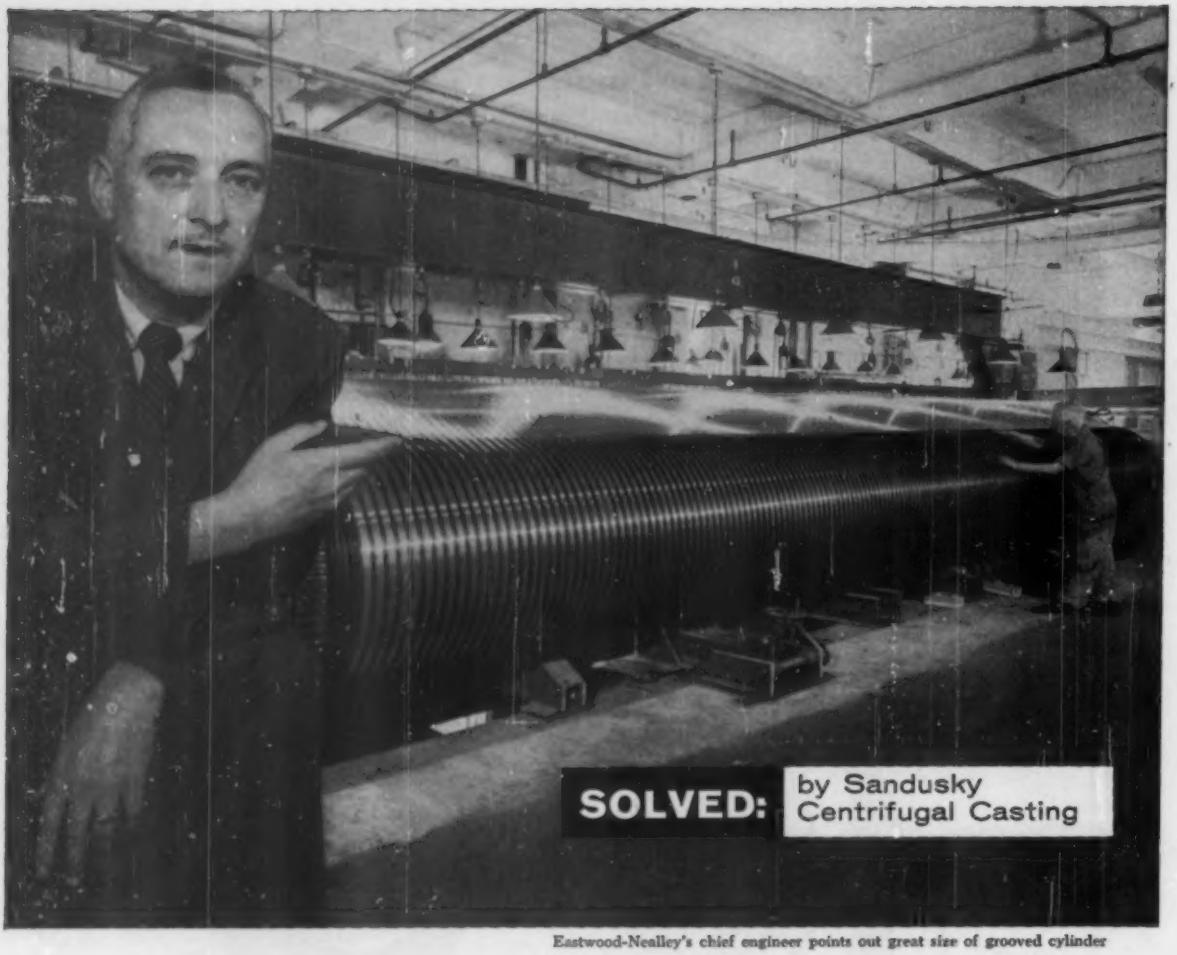
DESIGNERS and ENGINEERS



New 8-page Bulletin 200A includes specifications, performance and operating application data on new 2500 psi Denison balanced-vane hydraulic pumps. Write for your copy.

DENISON ENGINEERING DIVISION
American Brake Shoe Company
1240 Dublin Road • Columbus 16, Ohio

Circle 281 on Page 19



Eastwood-Nealley's chief engineer points out great size of grooved cylinder

Who else could cast this 22-ton cylinder for the world's biggest wire cloth loom?

To weave Fourdrinier wires up to 352" wide for the world's newest and largest paper machines, Eastwood-Nealley Corp., Belleville, New Jersey, required a cylinder over 30 feet long.

Sandusky supplied this 44,685 lb. roll, centrifugally cast of SAE-1030 steel and rough machined to 363" in length, 40⅝" on the O.D., to be used as the backbeam on Eastwood's new wire cloth loom. Since the cylinder had to be machined with 176 extremely smooth 2" x 2" stirs (grooves) in which wire is wound, it had to be of *flawless quality*. Otherwise any voids or inclusions exposed by machining would nick the delicate bronze strands and cause the expensive wire cloth to fail.

Eastwood-Nealley's chief engineer, Clemson A. Bower, asserts: *"We chose a Sandusky Centrifugal Casting because only Sandusky could make such a gigantic cylinder without welding. We were confident that our special machining operation would be accomplished without costly re-makes, for in the 12 years we have been using them, we never found a single flaw in a Sandusky Centrifugal Casting!"*

When cylinders or piping are needed in your design, keep Sandusky Centrifugal Castings in mind. We can supply cylindrical products from 7" to 54" O.D. and up to 33 feet long—made from a variety of alloys including stainless, carbon and low-alloy steels as well as copper- and nickel-base alloys. Send for free booklet, "Your Solution to Cylindrical Problems."

SANDUSKY CENTRIFUGAL CASTINGS
FOUNDRY & MACHINE CO.

6004 SANDUSKY, OHIO Stainless, Carbon, Low-Alloy Steels—Full Range Copper-Base, Nickel-Base Alloys



The record album, the bookmatch, and the box for milady's furs are just some of the hundreds of products guaranteed to be perfect when the paperboard comes from Continental Can Company. Whatever you design, make, fashion or fabricate—paperboard probably belongs. And, Continental Can Company makes the widest variety of paperboard—for the widest variety of uses—available anywhere. For every paperboard need, contact Continental Can Company... You can't buy better.

To learn more about the use of paperboard in all phases of industry, send coupon to: Paperboard and Kraft Paper Division, Continental Can Company, 633 Third Avenue, New York 17, N. Y.

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ROLLPIN is the slotted tubular spring pin with chamfered ends that is cutting production and maintenance costs in every class of industry. Drives easily into standard holes, compressing as driven. Spring action locks it in place—regardless of impact loading, stress reversals or severe vibration. ROLLPIN is readily removable and can be re-used in the same hole. Made in carbon steel, corrosion resistant steel and beryllium copper.

"WHERE SHOULD YOU BE USING ROLLPINS®?"

Thousands of companies—from cigarette lighter makers to car manufacturers—have learned from experience that ROLLPINS not only cut production and assembly costs, but make good products even better! The 9 examples pictured below don't even begin to indicate the range of application and usefulness of this simple, universal fastener. And naturally, they don't begin to show the cost and production savings you can achieve with ROLLPINS. If you aren't using ROLLPINS now, shouldn't you be? Write for a generous sample assortment and complete information. Dept. R62-114.

ROLLPIN REPLACES 9 DIFFERENT FASTENERS!



REPLACING A GROOVED PIN . . . here Rollpin serves as a stop pin. Its light weight and shear strength function perfectly . . . cuts assembly costs.



REPLACING A SET SCREW . . . a short length Rollpin is self-retained in the handle of an automobile brake. Is readily driven into over-drilled hole in shaft for easy removal.



REPLACING A HEADED PIN . . . in this hinge pin application, constant spring tension holds Rollpin firmly in place . . . eliminates loosening of hinge due to wear.



REPLACING A RIVET SHAFT . . . Rollpin serves as an axle for the sparkwheel of a cigarette lighter. No riveting or threading necessary. Faster assembly.



REPLACING A CLEVIS PIN . . . here Rollpin holds firmly in clevis, permits free action of moving member.



REPLACING A HUB ON A GEAR . . . Rollpin, self-retained in shaft, is simply snapped into molded slot to position sintered gear. Rollpin's shear strength is particularly valuable here.



REPLACING A COTTER PIN . . . Rollpin assembly time is shorter, service life ten times longer. Vibration-proof flush fit. Easily removable.



REPLACING TAPER PINS . . . Rollpin eliminates cost of taper pin reamers and the entire reaming operation. Rollpin costs less than a taper pin and installation is cheaper.



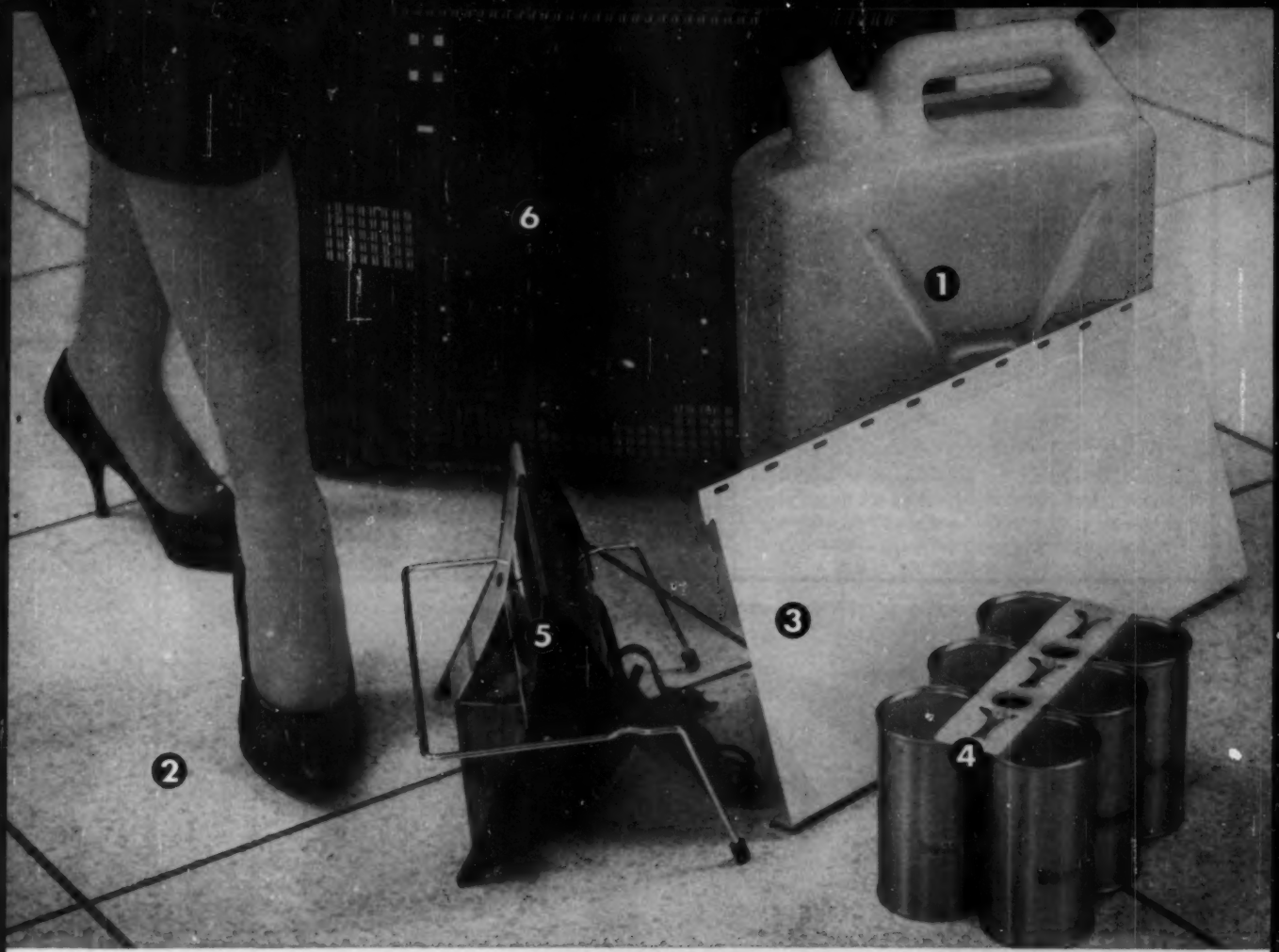
REPLACING A BOLT AND NUT . . . Rollpins act as fasteners and pivots . . . may also be used with a free fit in outer or inner members depending upon product design requirements.

ESNA®

ELASTIC STOP NUT CORPORATION OF AMERICA

2330 Vauxhall Road, Union, New Jersey

ROLLPIN®



NEW DESIGN IDEAS IN PLASTICS

(Could one of them spark the solution to your problem?)

1 POLYETHYLENES—New lightweight container is ideal for a variety of liquids. Molded from BAKELITE high-density polyethylene, it is corrosion- and scuff-resistant. BAKELITE polyethylenes offer a broad range of properties: strength and sparkling clarity for film packaging, moisture- and grease-resistance for extrusion-coated packages, excellent insulating qualities for wire and cable, light weight for pipe.

2 EPOXIES—Epoxy terrazzo floors have more than twice the compressive strength of concrete terrazzo. Weight is cut 75% because ¼"-thick epoxy terrazzo equals performance of 1"-thick concrete-type. BAKELITE epoxies, among the strongest and hardest plastics known, are ideal for industrial coatings, adhesives, reinforced laminations (medium-to-long-run tools and dies).

3 VINYLS—Vinyl-based coatings on aluminum and steel are baked onto metal before forming. Provide excellent weather resistance with no cracking, chipping, or peeling. Offering high electrical resistance, formability, color and elastomeric qualities, BAKELITE vinyls can be easily fabricated into such products as swimming pool liners, extruded wire insulation, and as jacketing for conduits.

4 STYRENES—Beverage cans effortlessly snap on and off this handsome new 6-pack carrier made from BAKELITE medium-impact styrene. Styrenes offer the designer a wide range of impact strengths, brilliant colors, glowing finishes. Molded and extruded styrenes are ideal for toys, containers, housewares, refrigerator door liners, portable TV cabinets.

5 PHENOLICS—All-phenolic base housing for this newly designed sunlamp offers low heat conductivity, superior toughness. BAKELITE Brand phenolic has high dimensional stability, very good machinability. Rich, glossy, smooth finishes. Ideal for all critical wet-dry conditions . . . and for bottle caps, chemical-resistant coatings, industrial or decorative laminates.

6 POLYPROPYLENES—High heat resistance, plus lightweight strength and excellent dielectric properties, make BAKELITE polypropylenes ideal for TV backs. Its outstanding chemical-, fatigue-, and stress-cracking resistance make it well-suited for pipe, housewares, auto accessories, webbing for outdoor furniture and many other uses.

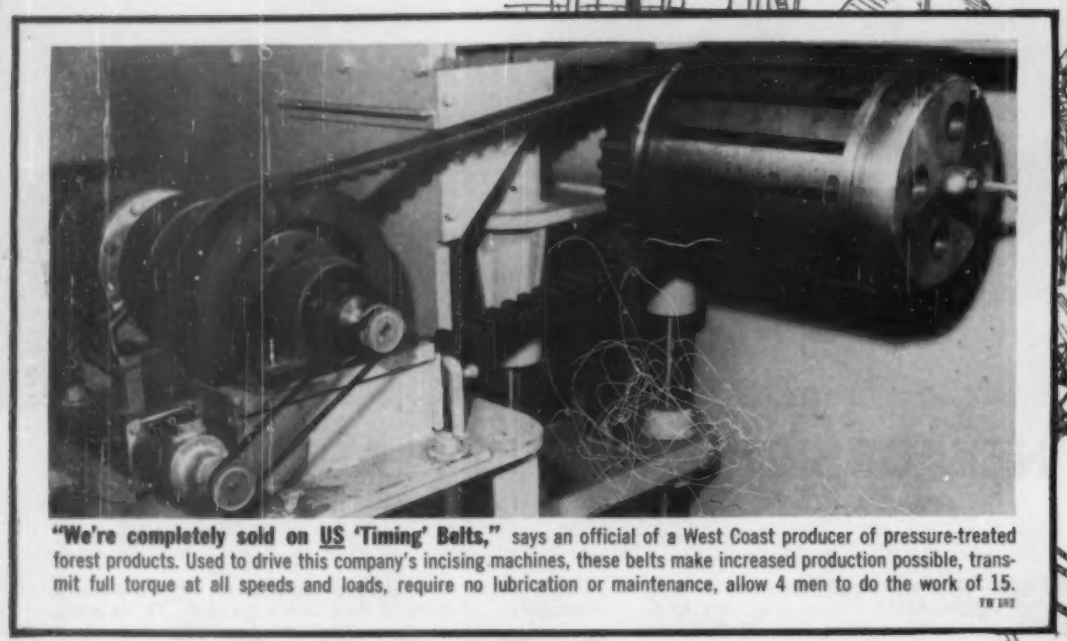
For information on application of these materials and processes to your products, write Dept. JW-84K, Union Carbide Plastics Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, New York. Be sure to ask for your copy of the "Materials and Data Guide" which describes in detail the full range of BAKELITE Brand plastics.

UNION CARBIDE **PLASTICS**

Circle 285 on Page 19

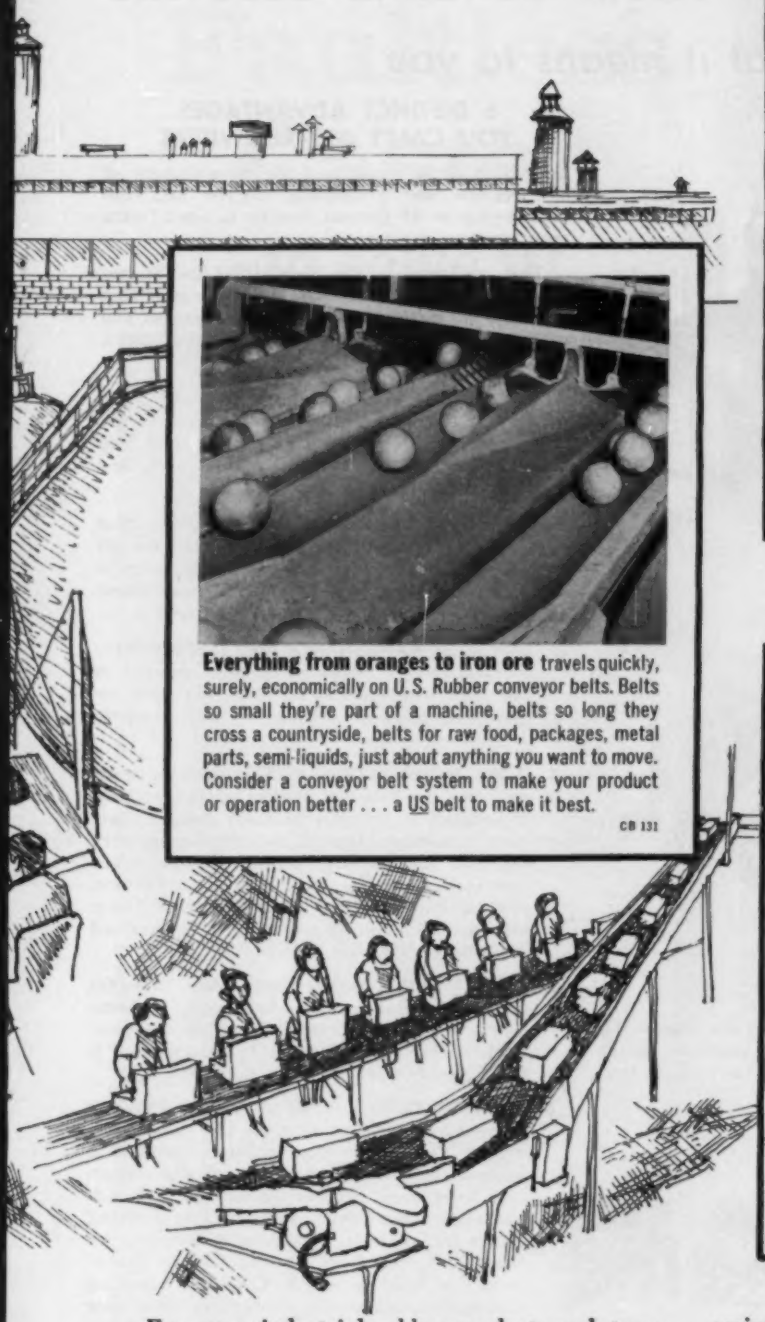
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US AT THE HEART OF INDUSTRY...



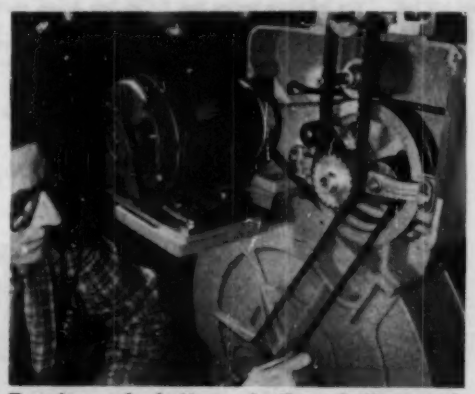
"We're completely sold on US 'Timing' Belts," says an official of a West Coast producer of pressure-treated forest products. Used to drive this company's incising machines, these belts make increased production possible, transmit full torque at all speeds and loads, require no lubrication or maintenance, allow 4 men to do the work of 15.

Whatever the machine, whatever its purpose, that purpose is often served better by the inclusion of one or more US Industrial Rubber Products—job-proved products that continue to demonstrate their value and versatility to designers and engineers throughout industry.



Everything from oranges to iron ore travels quickly, surely, economically on U. S. Rubber conveyor belts. Belts so small they're part of a machine, belts so long they cross a countryside, belts for raw food, packages, metal parts, semi-liquids, just about anything you want to move. Consider a conveyor belt system to make your product or operation better . . . a US belt to make it best.

CB 131



Teaming up for better projection...better sound, dependable US V-Belts and "Timing"® Belts are vital to the performance of Century movie projectors. These projectors must often run 12 hours in a row. The US belts insure silent running, keep projectors going at the exact speed required, guard against audience-annoying breakdowns.

VB 106



Most recommended for superheated and saturated steam at temperatures to 750°F., US asbestos-base Style 899 Sheet Packing also gives superior service with ammonia, gases, oils, gasoline, some acids, alkaline solutions, and other chemicals. Made of specially selected long-fiber asbestos, Style 899 Sheet Packing won't soften, burn or blow at joints and flanges.

P 163

For every industrial rubber product need, turn to US. For Conveyor Belts, V-Belts, the original PowerGrip "Timing"® Belt, Flexible Couplings, Mountings, Fenders, Hose and Packings . . . custom-designed rubber products of every description. Discover why U.S. Rubber has become the largest developer and producer of industrial rubber products in the world. See your U.S. Rubber Distributor or contact US directly at Rockefeller Center, New York 20, N. Y.

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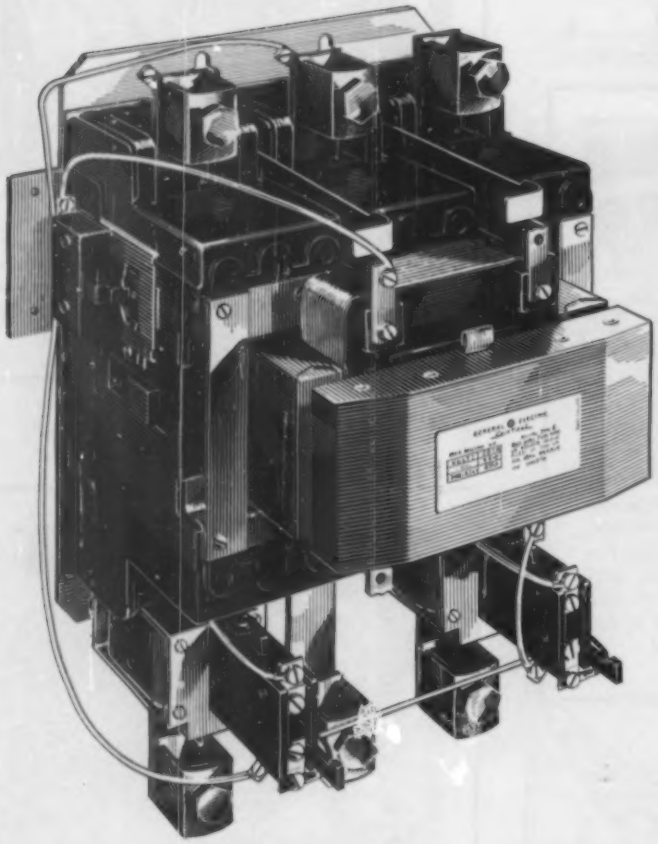
United States Rubber

MECHANICAL GOODS DIVISION

Circle 286 on Page 19

THE NEWEST STARTER FROM GENERAL ELECTRIC

... and what it means to you



NEW NEMA SIZE 5 STARTERS now added to G-E 100-Line feature extremely small size, plus all 100-Line benefits: Height—14⅛"; Width—11¾" Area—167.4 sq in.



NEMA SIZE 00	NEMA SIZE 0	NEMA SIZE 1	NEMA SIZE 2	NEMA SIZE 3	NEMA SIZE 4
H-4 1/2"	H-4 1/2"	H-4 1/2"	H-6 5/8"	H-9 1/2"	H-10"
W-5 3/32"	W-5 3/32"	W-5 3/32"	W-6 1/4"	W-8 5/8"	W-8 5/8"
A-22.9 sq in.	A-22.9 sq in.	A-22.9 sq in.	A-41.6 sq in.	A-76.5 sq in.	A-86.2 sq in.

6 DISTINCT ADVANTAGES YOU CAN'T GET ELSEWHERE

General Electric announces the development of new NEMA Size 5 magnetic starters and contactors—up to 65 percent smaller in open forms than previous designs.

This addition to the G-E 100-Line Starter "family" means you can now get seven sizes that give you six distinct, measurable advantages you cannot get from any other single brand of motor control. They are:

1. **SMALLER SIZE**—particularly in the more popular forms (Sizes 0 and 1). On larger forms, reduced height (as much as 41 percent on Size 5 units alone) saves critical panel space. See dimensions at left below.
2. **EASE OF WIRING**—all terminals are "out front," visible and accessible. Wiring for all sizes is straight through (this can save up to $8 in wire alone for Size 5 installations where line leads come in top and out bottom).
3. **SIMPLIFIED MAINTENANCE AND INSPECTION**—contacts can be inspected or coils changed in less than a minute on all sizes. No tools required on Sizes 00 through 4; only a screwdriver on Size 5.
4. **MORE MODIFICATION KITS**—industry's most complete line lets you modify existing starters on-the-spot in minutes to meet special operating conditions. Result: reduced change-over expense. All starter enclosures have cover knockouts for field-addition of push buttons, selector switches, and indicating lights. Other kits include auxiliary contacts, third overload relay, fuse clips, and coils.
5. **FIELD-*PROVED* DESIGN**—well over 1,000,000 units are operating in the field today. Exhaustive testing in laboratories and on customer applications since the 1957 introduction is your assurance of 100-Line dependability.
6. **"FAMILY" DESIGN BENEFITS**—G.E.'s 100-Line offers all forms and sizes in the same basic design. You benefit from common installation procedures; common maintenance and inspection techniques; reduced inventory; and such operating conveniences as adjustable overload relays for all sizes. Mounting dimensions for Sizes 00, 0, and 1 are identical; so are dimensions for Sizes 3 and 4. Common mounting dimensions and wiring procedures save time and space during panel layout; also when changes occur in horsepower requirements or industry specifications.

Meet all your control requirements—up through 200 hp—with the uniform, field-proved 100-Line, available in all popular forms: Sizes 00, 0, 1, 2, 3, 4, and 5 contactors and starters; plus combination starters; reversing and two-speed controllers. Contact your G-E sales engineer or distributor, or write Section 811-19, General Electric Company, Schenectady 5, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Whatever your design problem there is a

Faultless Caster

to solve it!





Design Problem:
Shimmyless, Quiet-running Caster for Hospital Carts and Stretchers

Solution:
Series 2400 Medium Duty Swivel Stem Truck Caster. Hardened ball bearings running in 2 raceways machined to closely held tolerances. Precision adjustment of swivel assembly eliminates troublesome wobbling of ordinary kind. 5", 8" or 10" dia. wheels for smooth, noiseless rolling.



Design Problem:
V-Grooved Wheel to Follow Angle Iron Tracks

Solution:
Light, medium and heavy duty casters are available with 4" to 10" V-Grooved Wheels to carry loads from 325 lbs. to 15,000 lbs. along unobstructed tracks. Save floor surfaces, eliminate noise and vibration. V-Grooved Wheels have flat outer treads for use on floors.



Design Problem:
Cushion Action Caster for Level Ride over Irregular Floors

Solution:
Series SH300 Spring Action Swivel Plate Truck Caster eliminates bounce. Caster maintains continual floor contact. Durable, long-lasting spring and draw bars, on center line of wheel, absorb shock and lengthen life of ball bearings, raceways and wheels.



Design Problem:
Scaffold and Platform Caster that Double Locks against Movement

Solution:
Series C900 Scaffold Caster has Brake that simultaneously locks both swivel and wheel. Scaffold will not creep. Foot or hand operated brake lever locks in up position . . . releases in down position. Large diameter wheel for a smooth rolling over ordinary obstacles.



Design Problem:
Sealed Caster Bearings for Use in Extreme Temperatures or Moisture-laden Air

Solution:
Series 900 GS Swivel Plate Truck Caster has built-in protective grease seals around main load, thrust and wheel bearings. Exclude water, chemicals, dirt. Prevent grease leaking to floor, assure easy maintenance, low upkeep.



Design Problem:
Exciting, All-New Caster Concept To Enhance Your New Furniture Line

Solution:
Royal-Roll, the "King of Casters" combines unique styling and time-tested furniture caster engineering. Double ball bearing swivel, non-marking wheel and hooded horn. Spherical black wheel with bright nickel or brass horn. Stems for wood, tubular metal and cast legs.

For FREE Condensed Catalog, or more information on specific Casters, fill out coupon today. Or contact your nearby Faultless Distributor who is listed in classified directory under Faultless heading.



Tell me more about:

- ☐ Series 2400
- ☐ V-Grooved Wheel
- ☐ Series SH300
- ☐ Series C900
- ☐ Series 900 GS
- ☐ Royal Roll

Faultless Caster Corporation
Evansville 7, Indiana

Name_____

Title_____

Company_____

City_____ State_____

Circle 288 on Page 19

1000 INCH-LBS. TORQUE THAT SMALL ?



You can use these new Globe planetary gearmotors to replace units 5 to 10 times as large and heavy. They slash pounds of dead weight from your design—give you up to 500 inch-pounds continuous duty or 1000 inch-pounds intermittent duty torque. Here's enough brawn to handle aircraft, missile and other high-quality, high-reliability jobs. Smaller gearbox shown above gives 200 in.-lbs. intermittent, 100 in.-lbs. continuous duty.

Globe's brand new planetary gearing system provides 22 ratios from 1.87:1 to 5211:1. Stage efficiency of 90% or better has been achieved by using heavy duty precision ball bearings on every gear and on the output shaft. Heat treated gears and hardened output shaft withstand enormous turning and bending moments. Type BD and BL gearmotors fit your application exactly, using 21 standard armature windings for 4 to 115 v.d.c. power—custom design for your application can include speed governors, brakes, and clutches. 1¾" flange gearmotor typically weighs 1½ lb.; 3" flange high-torque gearmotor weighs 4¾ lb. typ.

Let Globe engineers review your application early in the design stage. Prototypes furnished promptly. Write for Bulletin BPG. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio. Phone BAldwin 2-3741.

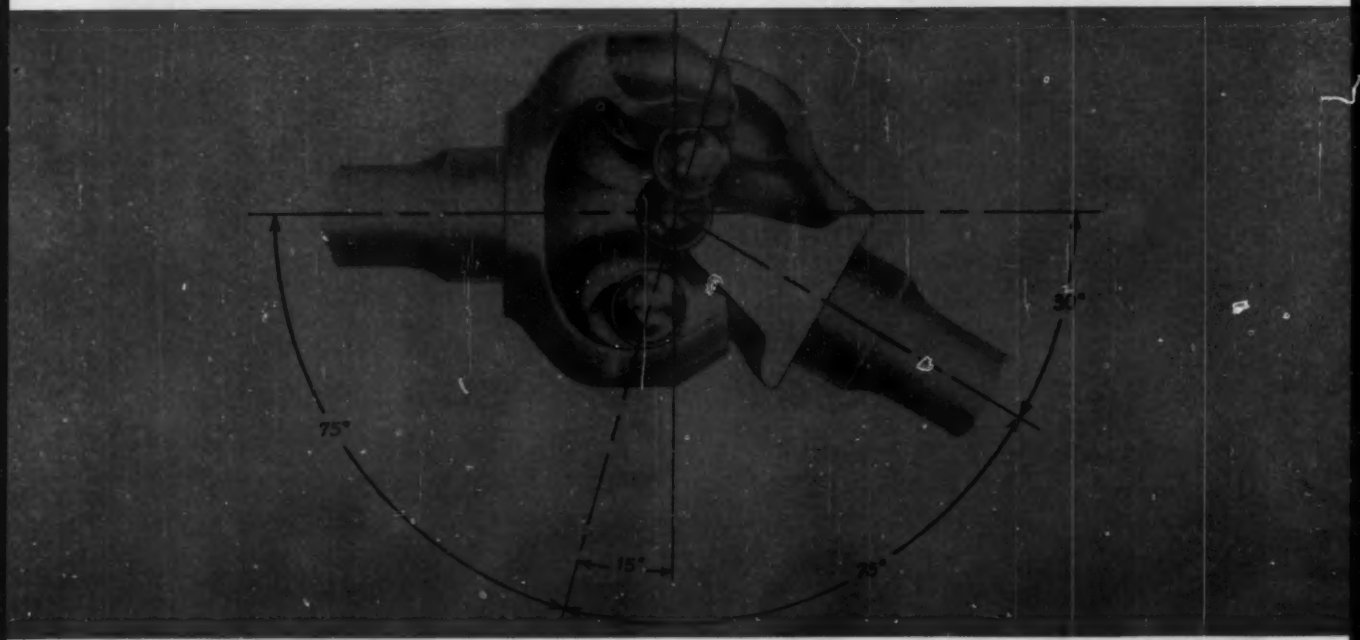
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CHOOSE BENDIX C-V UNIVERSAL JOINTS FOR LARGE-ANGLE, HIGH-TORQUE APPLICATIONS

The Bendix® Constant Velocity Universal Joint transmits angular movement at uniform velocity . . . at all shaft speeds, angles, torque loads. Types available to allow end motion; leave shafts unburdened by slip joints. Compact, spherical shape reduces space requirement. Send for free, detailed brochure: Bendix Automotive Products Division, South Bend, Indiana.





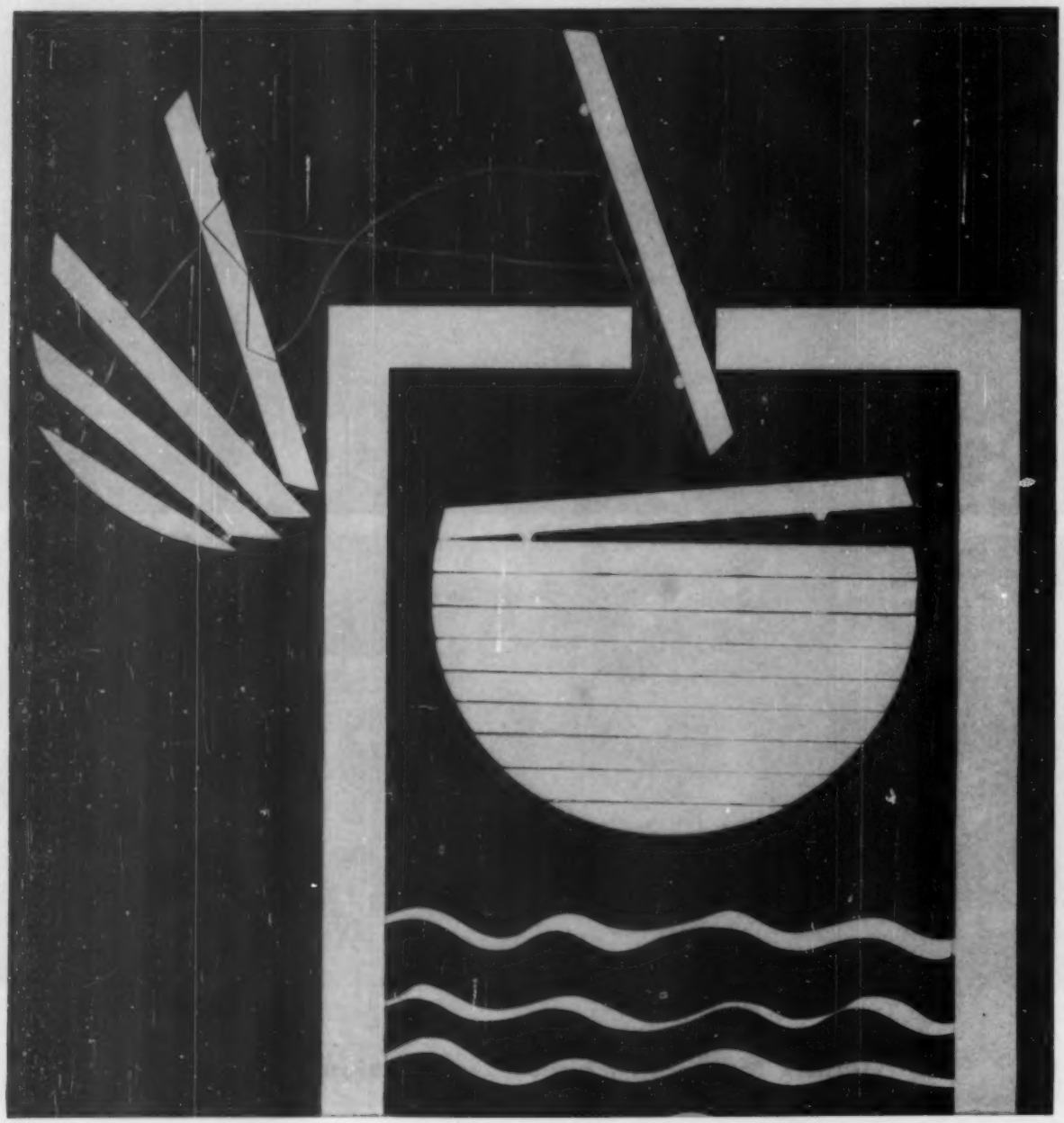
Bendix Products Automotive Division

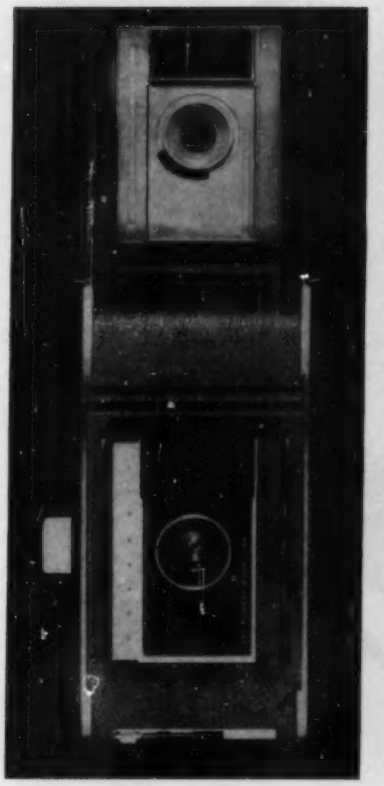
THE Bendix CORPORATION

Circle 290 on Page 19

Foam plastic ends waterlogging of pressure tanks

The most common problem with home water systems has been in maintaining the right amount of air in pressure tanks. Mechanical air controls haven't done the job because water quickly corrodes their metal parts. Now, Baker Manufacturing Company of Evansville, Wisconsin, has developed the Monitor AirSaver Float molded from lightweight DYLITE® expandable polystyrene. The moisture-proof float covers the surface of the water, and ends air absorption which causes troublesome waterlogging. Even though it's half submerged in water and must constantly withstand pressures of 20 to 40 lbs. psi, the float is guaranteed for 5 years. Designed to install in minutes, the float has a series of DYLITE bars which are highly resistant to rotting, leaking, corrosion and chemical action. They are inserted, one at a time, through a hole in the top of the pressure tank. Tensioning springs lock the bars together, and make the float airtight.





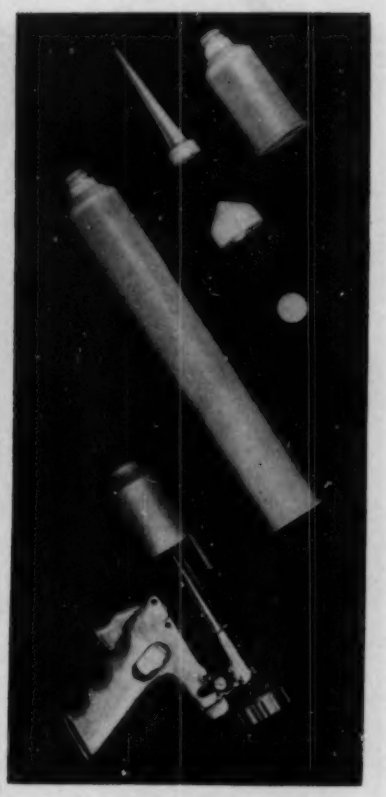
Polaroid uses plastic to hold "electric eye"

When Polaroid designed their new J-66 Land Camera, they needed a strong, heat-resistant material for the front section which secures the electric eye. After investigating many plastics, they chose an easy-to-mold Koppers polystyrene—DYLENE® Type 80. The durable plastic section fits perfectly around the electric eye to keep it firm. DYLENE is easily moldable, speeds production, eliminates costly secondary operations, and doesn't warp when exposed to extreme heat. Investigate versatile DYLENE polystyrene and see how you can lower costs and improve product performance and appearance.



Cooler liner formed without thin spots

The interior liner of this Hamilton-Skotch picnic chest is thermo-formed from SUPER DYLAN® high-density polyethylene. This impact-resistant plastic is used because it's the only polyethylene that can be formed into this difficult deep-draw piece without producing thin spots or mold marks. The seamless liner won't leak, absorb food odors or water. Its smooth, white finish can't stain, discolor, rust or corrode—it's easy to keep clean. Bottles, cans and chunks of ice won't mar or crack its tough surface. Cooler Chest manufactured by The Hamilton-Skotch Corporation, New York 16, New York.



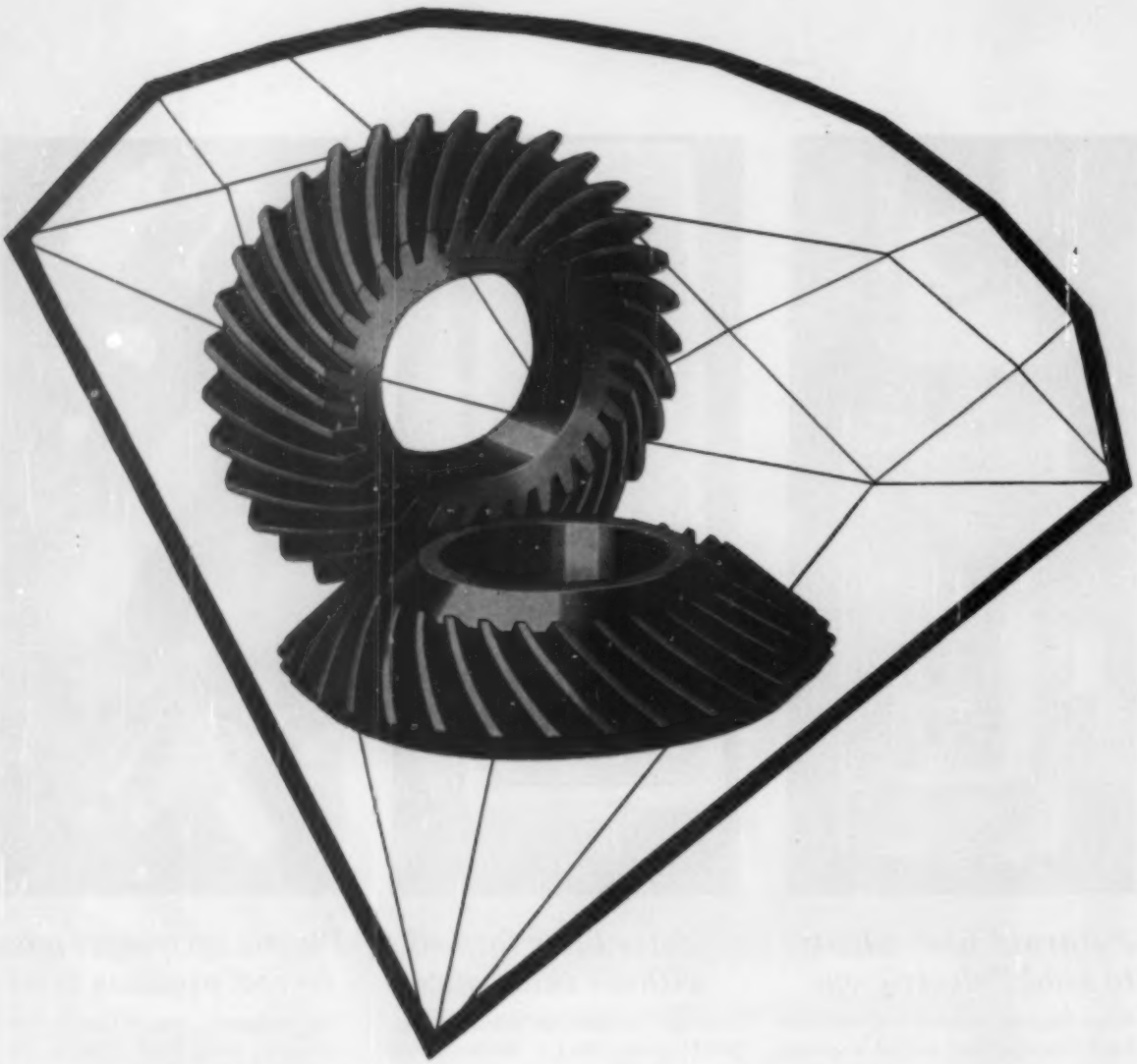
Plastic cartridges pass freeze, pressure tests

Pyles Industries, Inc., of Detroit, manufactures air-operated caulking guns for the automotive and aircraft industries. To extend storage life of caulking compound, Pyles makes freezable cartridges. Before they selected a cartridge material they tested a number of polyethylenes. Filled test cartridges were quick-frozen at temperatures as low as −80°F. Next, they had to withstand air pressures of 80 to 200 lbs. psi without blowing out or stripping threads on the plastic nozzle. Other polyethylenes became brittle and cracked, but tough DYLAN® polyethylene didn't weaken after repeated freeze and pressure tests.

KOPPERS PLASTICS

No matter what your design problem, investigate our complete line of polyethylenes and polystyrenes. Contact Koppers Company, Inc., Plastics Division, Dept. 1213, Pittsburgh 19, Pa.

KOPPERS



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BCA DELIVERS NEW DESIGN DATA

for personal discussion on all ball bearing applications!

Whenever BCA submits engineering drawings and calculations to a customer for a new ball bearing application, they're delivered in person by a BCA engineer. He can discuss the problem and our suggested solution, explaining how and why this particular design is best for the job to be done. Only in this way can you get the personal consultation essential to solving many bearings problems.

When new ball bearing applications or design changes are required, BCA engineers to the precise degree that operating conditions require. Bearings *must not* be under-engineered, at a risk of bearing failure: neither should they be over-engineered, at unnecessary extra cost. These are but a few of the factors which must be considered in bearing design. This is why the BCA personal approach offers a decided advantage to our customers.

Another important BCA "extra" is unusual flexibility in operation. Because we can eliminate red tape and wasted time, many of our customers have found we can even handle delivery or production emergencies in good order.

BCA also has available complete new research and engineering facilities and equipment. Included are special bearings testing machines which can duplicate many of the customers' actual operating conditions.

BCA makes ball bearings for OEM and replacement use, for almost every industry . . . construction, agriculture, automotive, machine tool. They're available in a complete range of sizes and types. For information or for technical assistance on bearings problems, contact Bearings Company of America, Division of Federal-Mogul-Bower Bearings, Inc., Lancaster, Pa.

BEARINGS COMPANY OF AMERICA

ball bearings

DIVISION OF
FEDERAL-MOGUL-BOWER
BEARINGS, INC.

Circle 292 on Page 19

Now—Finishes Add Beauty to Tough Malleable Castings

Beautiful, protective finishes on tough Malleable iron castings will give your products a superior combination of appearance, ruggedness, and economy. Get complete information on this sales-getting combination from any of the progressive companies that display this symbol —

MEMBER
MALLEABLE
CASTINGS COUNCIL



New Ideas for your products are suggested in Data Unit No. 115, available free from any member of the Malleable Castings Council, or write to Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.



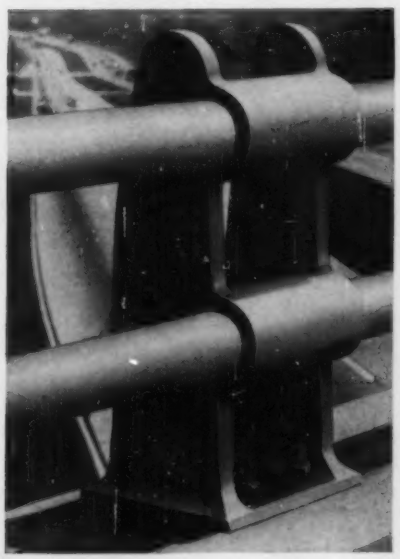
The castings shown have been painted, blued, chromium and cadmium plated, plastic coated, porcelain enameled, galvanized, and machined.

When appearance and long service life are important to your products, Malleable castings offer many advantages. Painting, hot dip galvanizing, blueing, and electroplating have long been used with Malleable castings because of their economy, attractiveness, and resistance to a variety of destructive conditions.

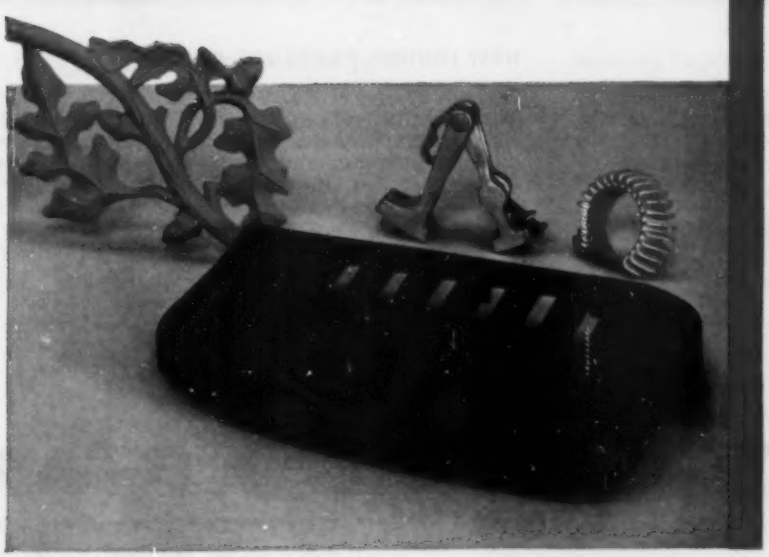
Several exciting new finishes appear very promising and are currently being tested by Malleable producers. Vinyl plastic in thin, contour-hugging films or thick, resilient coatings provide exceptional chemical resistance, and are available in a wide spectrum of strikingly beautiful colors.

Another attractive finish is porcelain enamel. In addition to smooth, gleaming surfaces in unlimited colors, it has excellent resistance to heat and chemicals.

The variety of finishes which can be successfully applied to Malleable gives designers outstanding opportunities to combine decorative and protective surfaces with the rugged dependability, economy, and versatility of Malleable castings. Call your Malleable supplier for information and quotations.



Bridge railing posts on the Connecticut Thruway are Malleable castings for three important reasons: (1) strong, ductile Malleable offers far greater resistance to fracture upon collision than other materials tried, (2) Malleable is easily galvanized for additional salt air corrosion resistance, and (3) with thousands of these posts in use, Malleable's economy produced real savings.



For Quality and Economy Use

MALLEABLE

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Dayton Mall. Iron Co., Ironton Div., Ironton
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Meadville Malleable Iron Co., Meadville
Pennsylvania Malleable Iron Corp., Lancaster

TEXAS
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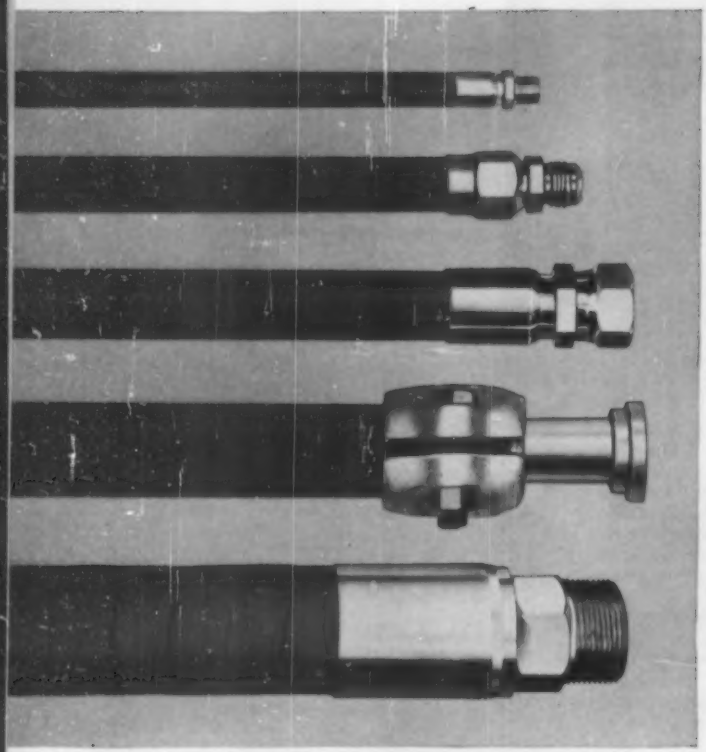
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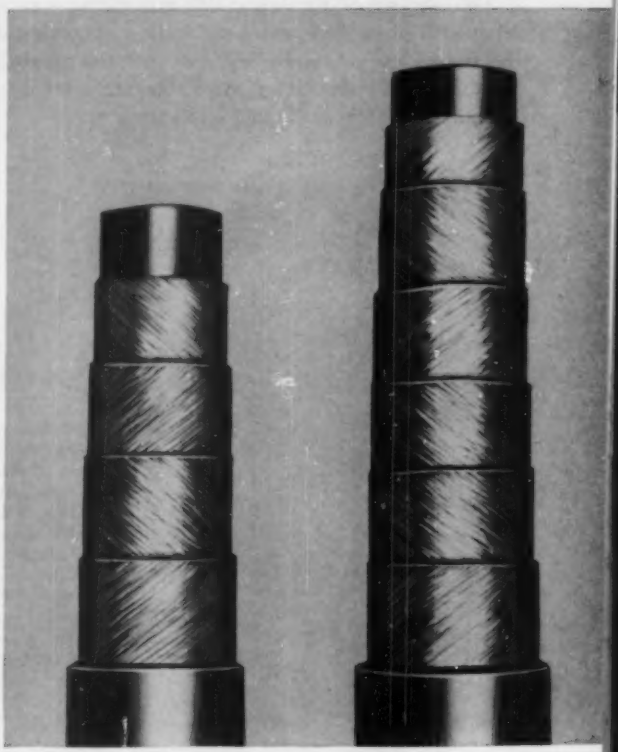
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Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company, Inc., West Allis 14
Kirsh Foundry Inc., Beaver Dam
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Circle 293 on Page 19

WHAT'S NEW IN HYDRAULIC ASK....IMPERIAL-





NEW EXPANDED LINE

With the addition of new products, particularly in higher pressure hose assemblies, the Imperial-Eastman line offers more than you will find elsewhere. Here's a complete line of wire braid hose, as well as Imperial-Eastman's new Hytron polyamide-polyester hose. Medium-pressure hose assemblies now include 2-spiral wire and 1-wire braid. High and super-high assemblies are available to meet working pressures to 10,000 psi. Couplings, adapters, adapter unions, fittings—we have them to meet all your needs.

NEW HIGHER PRESSURE ASSEMBLIES

Working-pressure requirements going up for you? Then look for problem solutions at Imperial-Eastman. Hose assemblies are now available in the high- and ultra-high-pressure ranges—up to 10,000 psi. Again, the completeness of the Imperial-Eastman line and the engineered, tested quality offer advantages you won't find elsewhere. Among Imperial-Eastman's new products are spiral wire hoses in sizes from ¼ to 2 in.—to withstand working pressures up to 10,000 psi. Other types withstand working pressures over 3000 psi.



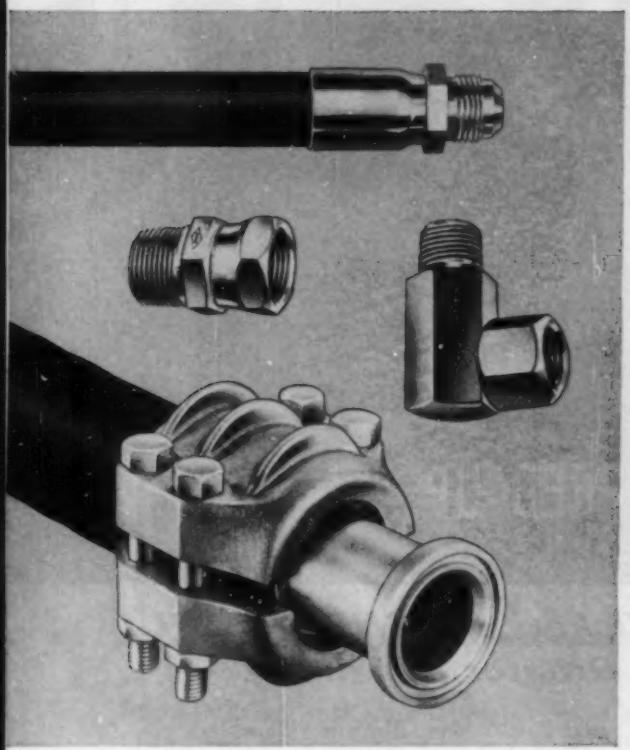
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IMPERIAL

Imperial-Eastman Corporation General Offices:
Imperial-Eastman Corporation (Canada) Ltd.,
Barrie, Ontario

HOSE ASSEMBLIES?
EASTMAN

New ideas, new research, new products plus an expanded line of hydraulic hose assemblies—these are developments now coming from Imperial-Eastman. It's a complete line—includes low- to ultra-high-pressure assemblies to meet your expanding needs. As always, the line reflects highest engineering and manufacturing standards.





NEW MATCHED-QUALITY COUPLINGS

You know that hose assemblies deliver best service with the proper application of couplings and fittings. From Imperial-Eastman you get matched quality in the complete assembly—with permanent or reusable couplings—and with adapters, adapter unions and other connectors. Now available is a new 4-bolt, clamp-type coupling which holds beyond hose burst pressure. Factory-assembled permanent couplings are applied by an exclusive Imperial-Eastman pressure-controlled process to assure absolute, matched-quality dependability.

NEW HYTRON® HOSE

This new polyamide-polyester hose solves many problems, meets many specifications as an alternative to one-wire braid SAE 100R1 hose. It has seven times the flex impulse life of wire braid, with comparable strength. Hytron hose also features excellent compatibility with mineral or synthetic fluids having either phosphate ester or water bases. Burst pressures from 8000 to 12,000 psi, depending on size—temperatures from −45° to 250° F. Hytron is available in long lengths—to 1000'; furnished with permanent or reusable couplings.

EASTMAN

6300 West Howard Street, Chicago 48, Illinois

Imperial-Eastman, S.A., Apartado Postal 26544, Mexico 13, D.F.

Circle 294 on Page 19

Imperial-Eastman Corporation, 6300 W. Howard St., Chicago 48, Ill.

MD-11-1

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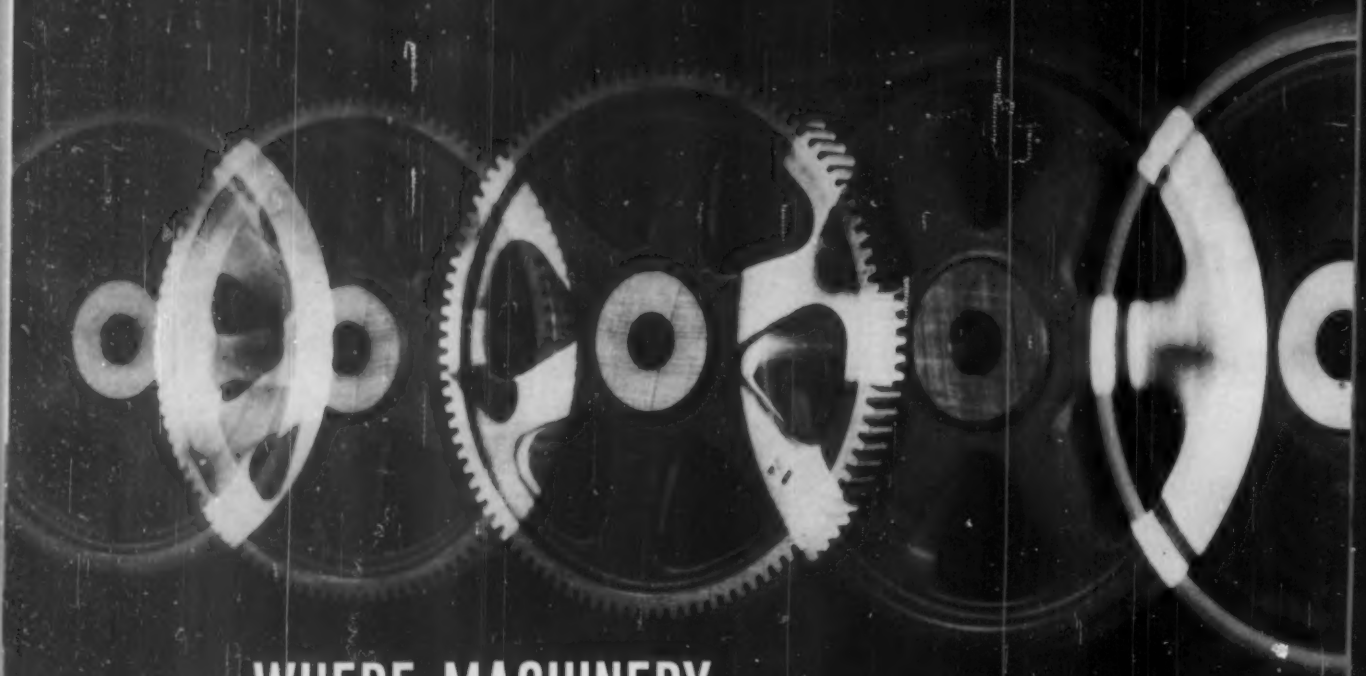
- ☐ The complete Imperial-Eastman line of assemblies
- ☐ High- and ultra-high-pressure assemblies
- ☐ Matched-quality couplings and fittings
- ☐ Hytron hose

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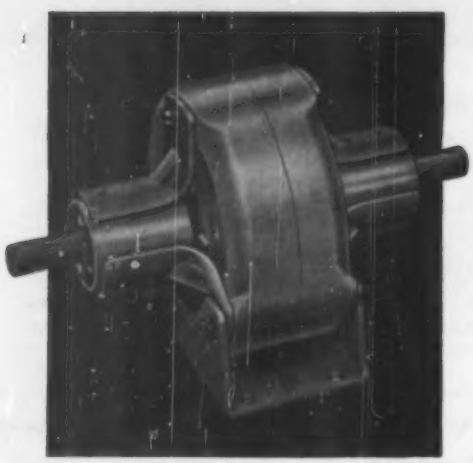
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WHERE MACHINERY MUST START...STOP SLOW DOWN...SPEED UP...

The Smoother Operating Vickers MAGNECLUTCH® Adds Longer Life and Greater Reliability



EPA 6000-7

Start . . . stop. Fast . . . slow. High slip . . . low slip. These conditions drive most clutches to early graves. They can't take the stresses and strains of no-speed low-speed high-speed in merciless repetitive cycles.

Now see how the Vickers MAGNECLUTCH meets this problem: There is no mechanical contact between rotating members. Torque is transmitted by the linking action of energized ferro-magnetic particles, and is independent of speed. Torque is a direct function of the clutch current. From stop to full speed, torque is transmitted in a smooth curve, without grab or chatter. *There is no stress or strain.* Result: the clutch is more reliable, lasts longer. Standard MAGNECLUTCHES (and MAGNEBRAKES) available from 11 oz.-in. to 600 lb.-ft.

Contact the Vickers field engineer in your area for complete information, or write for Bulletin Series 6000.

VICKERS INCORPORATED

Division of Sperry Rand Corporation

ELECTRIC PRODUCTS DIVISION

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Circle 295 on Page 19

Whatever you make... there's a

WALDES TRUARC RETAINING RING

designed to improve your product... lower assembly costs

function		for axial assembly					for taking up end-play					
							axial assembly				radial assembly	
nomenclature		basic		heavy duty	inverted		bowed		beveled		bowed e-ring	prong-lock®
												
series no.		5000 N5000	5100	5160	5008	5108	N5001	5101	5002 N5002	5102	5131	5139
application		Internal for Housings, Bores	External for Shafts	External for Shafts	Internal for Housings, Bores	External for Shafts	Internal for Housings, Bores	External for Shafts	Internal for Housings, Bores	External for Shafts	External for Shafts	External for Shafts
size range	in.	.250 – 10.0	.125 – 10.0	.394 – 2.0	.750 – 4.0	.500 – 4.0	.250 – 1.500	.188 – 1.500	1.0 – 10.0	1.0 – 10.0	.110 – 1.375	.092 – .438
	mm.	6.4 – 254.0	3.2 – 254.0	10.0 – 50.8	19.0 – 101.6	12.7 – 101.6	6.4 – 38.1	4.8 – 38.1	25.4 – 254.0	25.4 – 254.0	2.8 – 34.9	•

function		for radial assembly				self-locking types					
nomenclature		crescent®	e-ring	interlocking	reinforced e-ring	circular self-locking			grip-ring	triangular self-locking	triangular nut
											
series no.		5103	5133	5107	5144	5115	5105	5005	5555	5305	5300
application		External for Shafts	External for Shafts	External for Shafts	External for Shafts	External for Shafts	External for Shafts	Internal for Housings, Bores	External for Shafts	External for Shafts	With Threaded Screw
size range	in.	.125 – 2.0	.040 – 1.375	.469 – 3.375	.094 – .562	.094 – 1.0	.094 – 1.0	.312 – 2.0	.079 – .750	.062 – .438	•
	mm.	3.2 – 50.8	1.0 – 34.9	11.9 – 85.7	2.4 – 14.3	•	•	•	2.0 – 19.0	•	•

Truarc retaining rings are precision-engineered fasteners which simplify design, speed production and reduce material, machining and assembly costs. They may be used to retain components on shafts and in bores and housings .040" to 10" dia. – and rings as large as 40" dia. have been developed for special applications! Truarc rings are installed in easy-to-cut grooves and self-locking types are available which do not require any preparatory machining. Altogether, there are 50 functionally different types . . . some with as many as 98 sizes . . . in 6 metals and 13 finishes.

More than a fastener! Truarc rings function as mechanical components by replacing machined shoulders, set collars, rivets, threaded fasteners and other bulkier and more expensive fastening devices. They eliminate drilling, tapping, threading and other costly machining operations. Speed of assembly and disassembly further reduces manufacturing costs and simplifies field service.

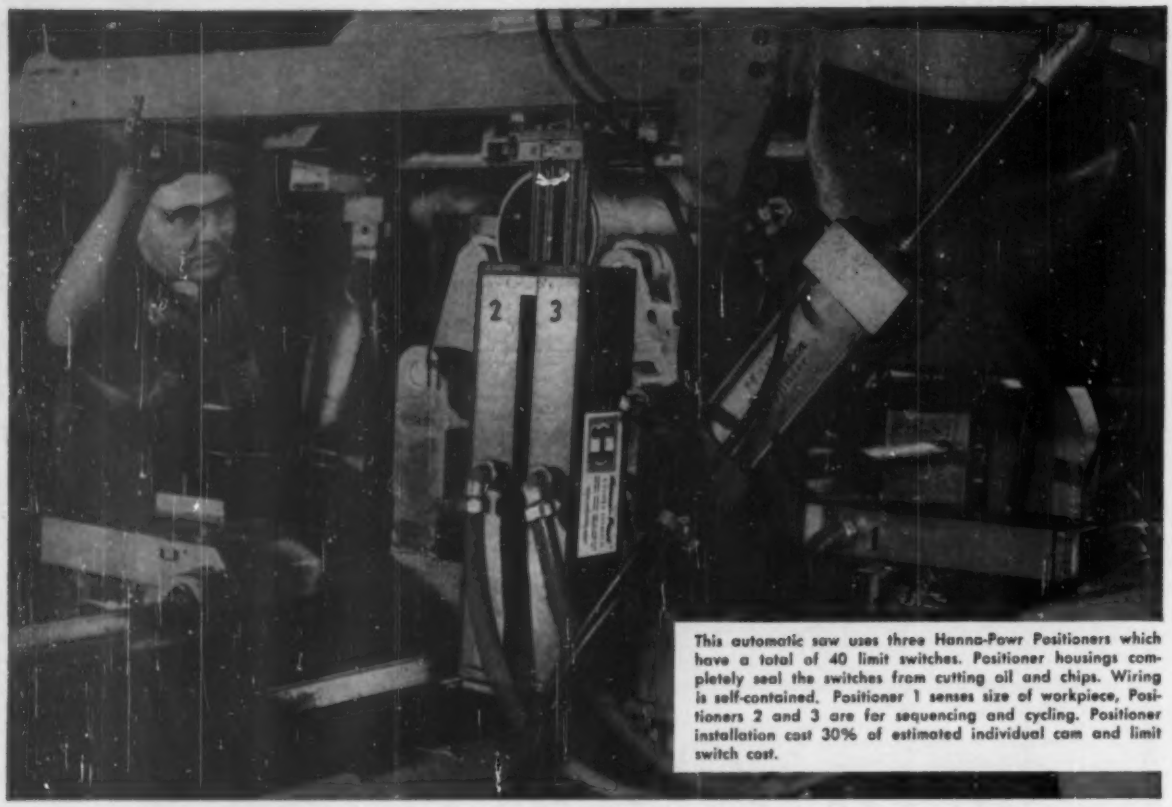
Assembly tools for every requirement: Truarc offers you the most complete line of pliers, applicators, dispensers and portable magazine-fed tools for high-speed ring installation . . . even fully mechanized and automated equipment for mass-production assembly operations.

Engineering Service: We'll be happy to help you solve *your* fastening problems. Send us your blueprints or contact your local Truarc representative or distributor. They're listed in the Classified Telephone Directory under "Retaining Rings" or "Rings, Retaining."

WALDES KOHINOOR, INC.

47-16 Austel Place • Long Island City 1, N.Y.

WALDES TRUARC® RETAINING RINGS



This automatic saw uses three Hanna-Powr Positioners which have a total of 40 limit switches. Positioner housings completely seal the switches from cutting oil and chips. Wiring is self-contained. Positioner 1 senses size of workpiece, Positioners 2 and 3 are for sequencing and cycling. Positioner installation cost 30% of estimated individual cam and limit switch cost.

Start a cam and limit switch COST REDUCTION PROGRAM!

You can cut cam and limit switch costs up to 70% by using the Hanna-Powr Positioner — a compact, dust and water-tight housing containing cam rods and limit switches.

Because the Positioner is a pre-engineered assembly, it saves time used in designing special cams and mountings. Installation costs are cut, too, because it is only necessary to mount one box (4 screws) rather than individual switches and cams. Wiring is greatly simplified. The Positioner housing serves as a junction box—one conduit connection does it.

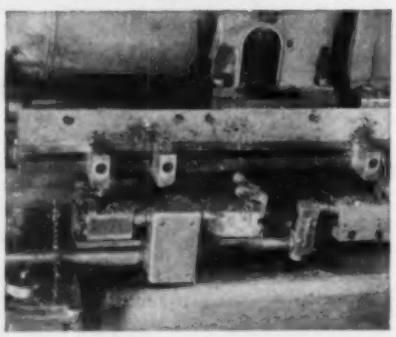
The switches can be moved easily and locked quickly in place after installation. This speeds set-up time for new jobs and makes pre-calculation of stops unnecessary. Safety is another big advantage—the switches cannot be tripped accidentally.

In addition to lower initial costs —maintenance, replacement, and down-time costs are cut. Switches last longer due to the protection (from dirt, chips, fluids and damage) afforded by the sturdy, extruded aluminum housing.

Use Hanna-Powr Positioners for cycling, sequencing, positioning, sensing and indicating. Many are in use and have been thoroughly tested in a variety of applications. It's a practical approach to automation.



Positioner containing switches and cam rods. Up to 28 switches per foot of travel. Any travel to 8 feet. Takes standard miniature or heavy duty limit switches, single or double throw.



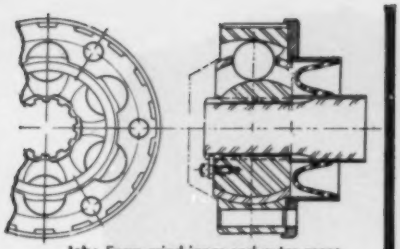
Examine your cam and limit switch costs. $35 to $75 per switch is the cost companies have fixed for designing, machining, installing, wiring, and adjusting limit switches and cams. This photo shows a typical high cost installation where oil, chips and accidental damage cause high failure rates and increased maintenance costs.

Write for complete catalog or consult Sweets' Product Design File section 9A/HA. Your Hanna Representative will also give you complete information—see the yellow pages under cylinders.

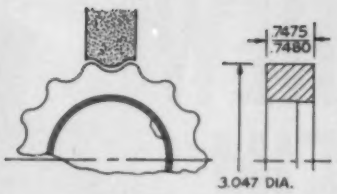
Hanna Engineering Works

1751 Elston Ave., Chicago 22, Illinois

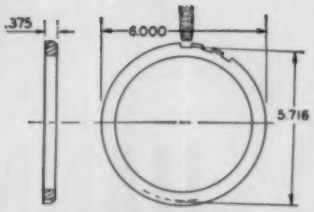
AIR AND HYDRAULIC CYLINDERS, VALVES, POSITIONERS



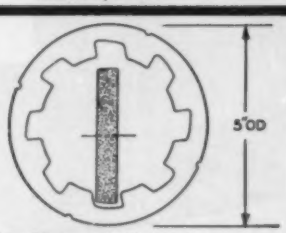
Job: Form grind inner and outer races and grooves and slots in ball cage of constant velocity universal joints.



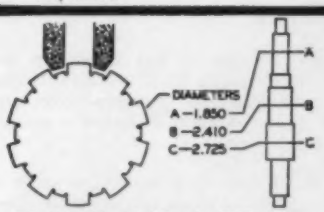
Job: Contour grind 14 lobes
Part: Pump rotor
Output: 88/hr, floor to floor
Material: Steel 200 Brinell
Pcs/load: 12



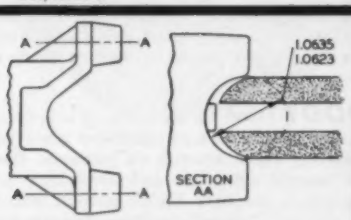
Job: Grind 24 teeth from solid
Part: Splined spacers
Output: 18/hr
Material: Steel
Pcs/load: 9



Job: Contour grind internal cams
Part: Roller clutch cam
Output: 60/hr
Material: Case hardened steel
Pcs/load: 2



Job: Straddle grind 3 sets of 10-splines (parallel sides)
Part: Transmission mainshaft
Output: 2.7/hr/spline set
Material: Steel 61-64 Rc
Pcs/load: 1

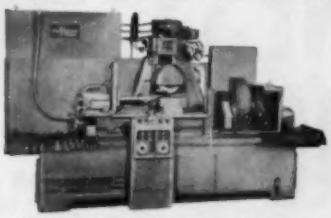


Job: Grind 2 half-rounds from rough
Part: Universal Joint
Output: 400/hr, floor to floor
Material: Pearl. Mall. Iron
Pcs/load: 10

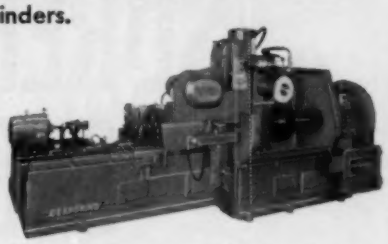
Now You Can Design for FULLY AUTOMATIC FORM GRINDING

to cut costs, improve accuracy on external and internal contours

Here are some examples. You now have greater freedom of design for all kinds of internal and external forms with assurance of top accuracy using versatile standard and special Detroit Automatic Grinders.



"Detroit" automatic contour grinder for up to 20″ PD.

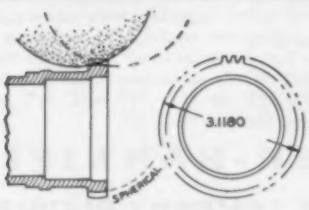


"Detroit" automatic contour grinder for up to 36″ external and 30″ internal.

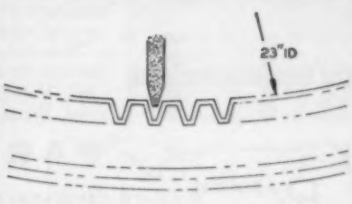
GEAR GRINDING MACHINES DIVISION

MICHIGAN TOOL COMPANY

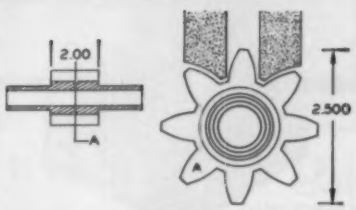
7171 E. McNICHOLS ROAD • DETROIT 12, MICHIGAN



Job: Spherical grind 48 teeth
Part: Spherical gear coupling
Output: 2.3/hr
Material: Carburized 60 Rc
Pcs/load: 1



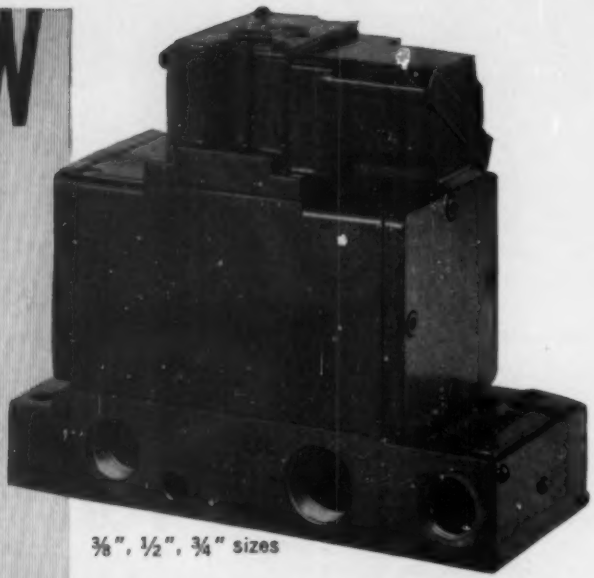
Job: Internal grind 157 teeth
Part: Aircraft reduction gear
Output: 1.2/hr
Material: Case hardened
Pcs/load: 1



Job: Straddle grind 8 teeth
Part: After-burner pump gear
Output: 11/hr, floor to floor
Material: Nitrided steel 15N-90
Pcs/load: 1

Circle 298 on Page 19

NEW HANNIFIN "HUSTLER" VALVES GIVE YOU SPEED, SURENESS & GOOD SERVICE



⅜", ½", ¾" sizes

ALL the features you want in 4-way, pilot-operated air control

HOW FAST? So fast it fills 12 cu. in. test chambers from 0 to 90 psi in 0.029 seconds. Larger, 100 cu. in. chambers fill in 0.075 seconds. Valve itself has been cycled on test over 3,000 times a minute. We know of no faster valve.

HOW SURE? Valve will operate on severely restricted air supplies and at pressures down to 15 psi, thanks to a reserve volume of pilot air, maintained at maximum line pressure in a self-restoring accumulator chamber (patent applied for). Low-wattage, nylon encapsulated, plug-in solenoids are guaranteed for life against burnout. New "Comb-O-Seals"—one-piece, pressure-energized—seal positively, cannot be improperly assembled. Any of today's varied air line lubricants can be used. Both pilot valve and main valves operate on poppet principle, cannot stick in dirty air.

HOW GOOD? Good for millions of leak-proof cycles! All-aluminum, die cast construction gives you light weight, assures clean, smooth air passages. Base mounting—all connections, air and electrical, are permanently made to the base. Quick plug-in feature —entire operating unit "plugs" into base; remove two screws and it lifts off easily and quickly. Locking manual over-ride is standard on all solenoid models. All models fully meet J.I.C. standards.



VALVES MOUNT ON 3⅛" CENTERS

ADD-A-FOLD BASES (optional) permit joining a number of valves together, with one supply, one exhaust, one gallery for electrical connections.

You can have either maintained or momentary contact electrical actuation—or remote pressure actuation. Valve is available in ⅜", ½" and ¾" pipe sizes. Write for new Bulletin 0611-B1.

PARKER HANNIFIN CORPORATION

PARKER-HANNIFIN

HANNIFIN COMPANY DIVISION

515 South Wolf Road • Des Plaines, Illinois

PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

EUROPEAN DIVISION • PARKER-HANNIFIN N.V. • SCHIPHOL • THE NETHERLANDS

3419-PH

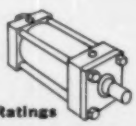


THIS ..IS WHAT YOU BUY!

POWER — clean, dry, drip-free power at the business end of a Hannifin piston rod is the result of Hannifin extra quality, and at no extra cost. Bores are honed to 15 RMS or finer... piston rods are case hardened, plated and polished to 10 RMS or better. Cartridge gland, removable without dismantling cylinder, has exclusive Hannifin-developed "Lipseal®-Wiperseal" combination for a truly drip-free rod.

Modern straight thread leak-proof ports for easily positioned fittings are available at no extra cost on hydraulic cylinders.

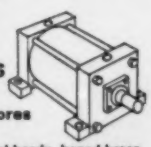
HYDRAULIC CYLINDERS



Two Pressure Ratings

2000 psi (3000 psi non shock), the famous heavy duty Hannifin Series "H" in 1½" to 12" bore.
1000 psi, Series "L", 1" to 8" bore, Hannifin quality in a lighter cylinder.
Full compliance JIC Hydraulic Specs.

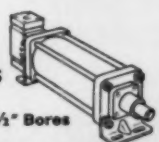
AIR CYLINDERS



1½" to 14" Bores

Series "A"—steel heads, honed brass body for corrosion resistance. Hardened and hard chrome plated piston rod. For all heavy duty air service. Easily modified for water service.
Full compliance JIC Pneumatic Specs.

AIR MOTORS



1¾" to 4½" Bores

New from Hannifin, a complete power package combining cylinder and solenoid valve. Only one air line connection. Four mounting styles. Interchangeable mounting dimensions for most applications.



PARKER-HANNIFIN

HANNIFIN COMPANY DIVISION
515 South Wolf Road • Des Plaines, Illinois
PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS
EUROPEAN DIVISION • PARKER-HANNIFIN N.V. • SCHIPHOL • THE NETHERLANDS

3128-PH

NEW—TWO LOW-COST MINIATURE BALL BEARING LINES

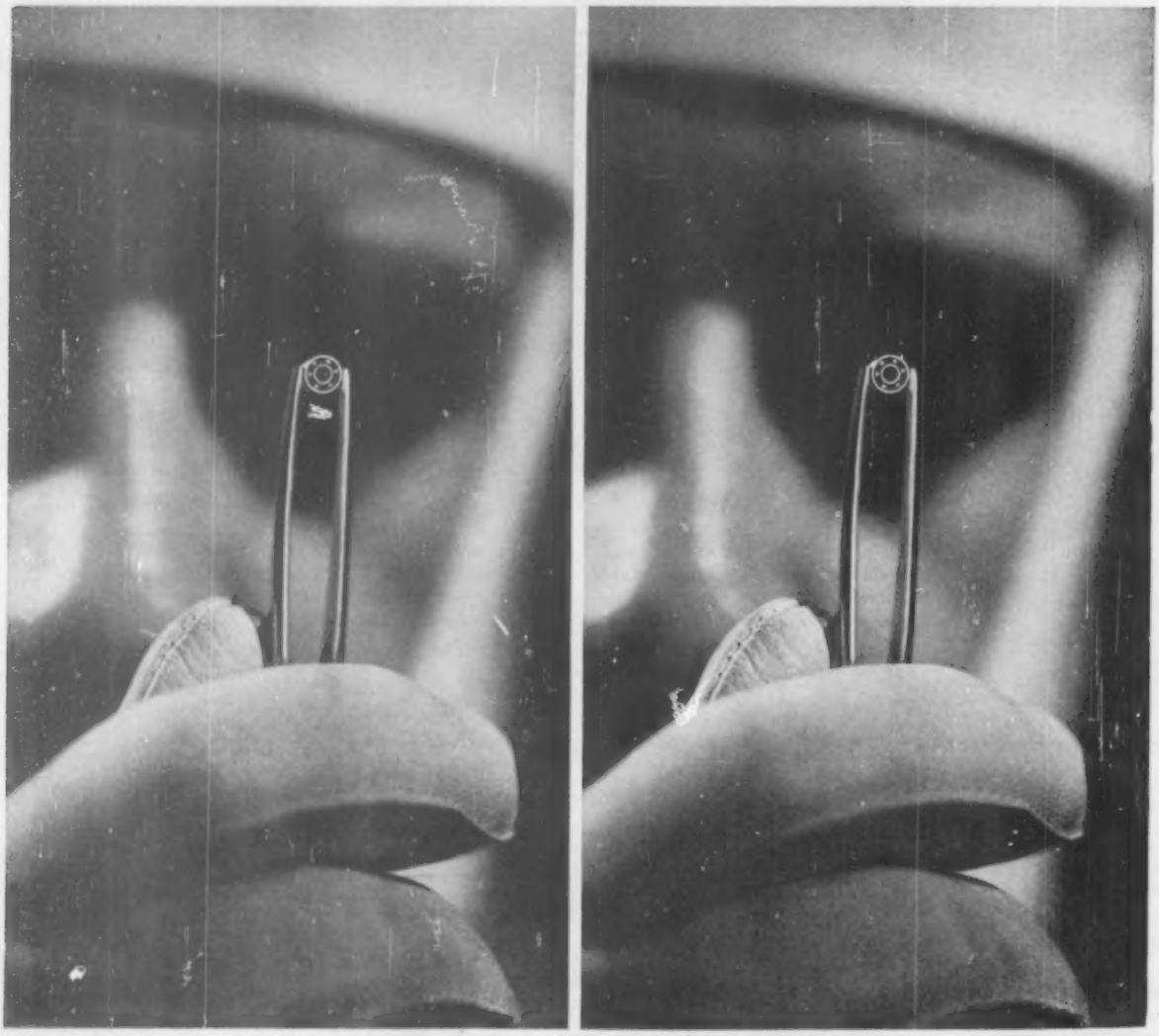
New Departure ABEC 3* and ABEC 5* miniature ball bearings now offer manufacturers of precision miniature potentiometers, gear trains, motors and similar precision products the opportunity to reduce bearing costs substantially.

New Departure ABEC 3 and ABEC 5 bearings can be used wherever the high precision and performance of ABEC 7 bearings are not required. They offer the engineer greater design versatility—he can select the most economical bearing for each application. Moreover, New Departure ABEC 3 miniature ball bearings can be used to upgrade products presently using precision sleeve bearings.

New Departure will continue to offer super precision ABEC 7 miniature ball bearings for your highly critical applications.

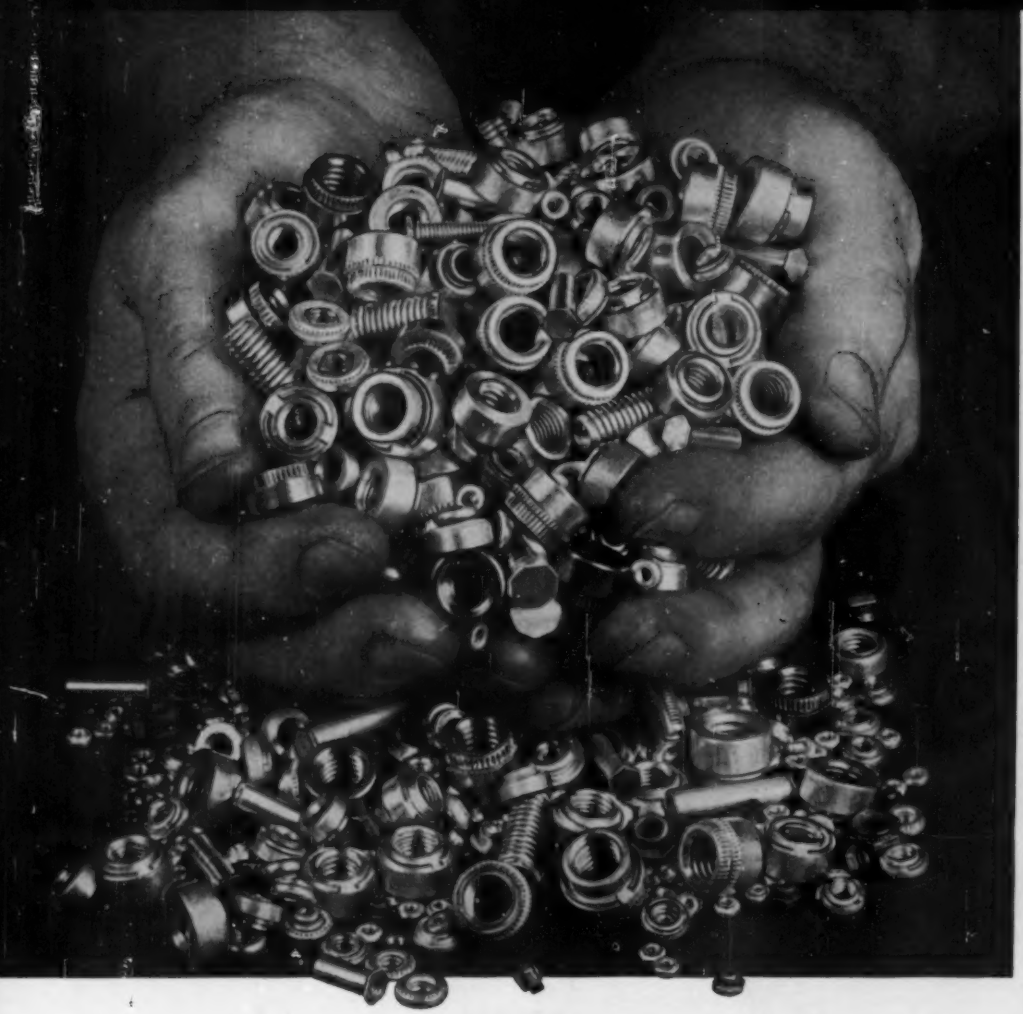
If you are planning a re-evaluation of your miniature bearing applications, it will pay you to consult the N/D Sales Engineer in your area. His assistance may help pave the way to reduced parts cost or enhance the quality of your product. For more information, write for booklet AST, NEW DEPARTURE, DIVISION OF GENERAL MOTORS CORPORATION, BRISTOL, CONN.

*Bearing tolerances as established by the Annular Bearing Engineers Committee of the Anti-Friction Bearing Manufacturers Assoc.



NEW DEPARTURE
MINIATURE AND INSTRUMENT BALL BEARINGS

Circle 301 on Page 19



Pay for themselves...*PLUS A PROFIT*... from Production Fastening Savings

Here is the means of cutting your costs in fastening sheet metal "too-thin-to-thread."

PEM self-clinching Fasteners—for every conceivable need—can serve 95% of your requirements. Can save more than that in use.

They are simply "clinched with a squeeze with the greatest of ease" to secure them into previously prepared holes.

There are standard self-clinching nuts; midgets of the same design; self-locking, self-clinching nuts; self-clinching flush fasteners; self-clinching captive studs; self-clinching floating nuts; self-clinching stand-offs and self-clinching spline fasteners—size, type, metal, finish, we have them all! Open your mind and your specifications to this unexcelled line of captive threads for production fastening.

You will be surprised at their economy and the added product quality they provide.

Circle 302 on Page 19

PEM

NEW

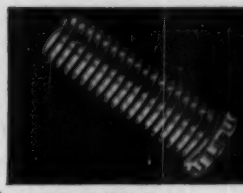


▶ MINIATURE SELF-CLINCHING FASTENER

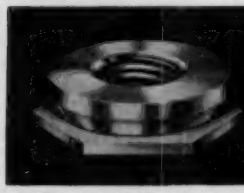
NEW



▶ MINIATURE SELF-CLINCHING, SELF-LOCKING NUT



▶ SELF-CLINCHING CAPTIVE STUD

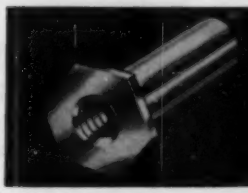


▶ SELF-CLINCHING FLUSH FASTENER

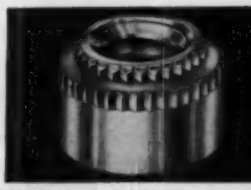
NEW



▶ FLOATING SELF-CLINCHING, SELF-LOCKING NUT



▶ SELF-CLINCHING STAND-OFF



▶ SELF-CLINCHING SPLINE FASTENER

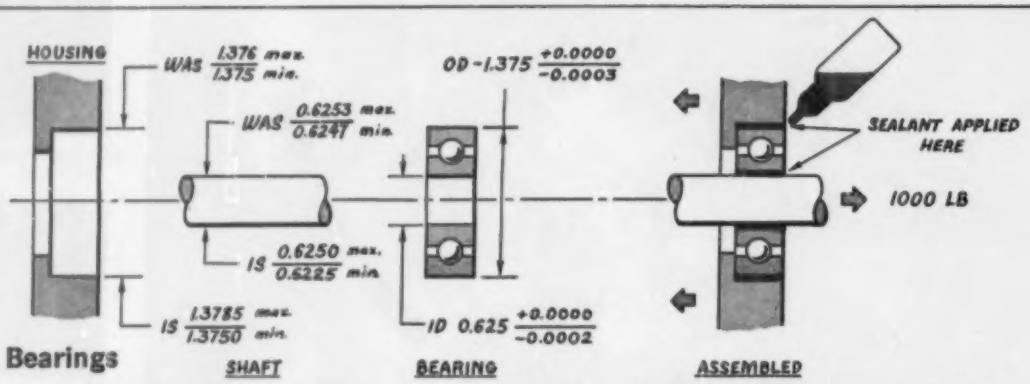
PENN ENGINEERING & MANUFACTURING CORP.

DOYLESTOWN • PENNSYLVANIA

NEW YORK (BELLE HARBOR, L. I.)—NEPTUNE 4-7103
CINCINNATI—GRANDVIEW 1-9011
CHICAGO (DOWNERS GROVE, ILL.)—WOODLAND 9-7779
MIAMI (SPYRAFLO, INC.)—NATIONAL 1-0556
SAN FRANCISCO (PALO ALTO)—DAVENPORT 1-2430
INDIANAPOLIS—CLIFFORD 1-4020
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MILWAUKEE—BLUEMOUND 8-6118
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DALLAS—FLEETWOOD 7-5713
LOS ANGELES—BRADSHAW 2-8097

SIMPLIFY ASSEMBLY...
Retain parts on shafts with slip fit and Loctite

Designing with liquid LOCTITE eliminates press fits, shrink fits, broaching, knurling, keyways, set screws and pinning ... provides easier tolerances ... cuts rejects and rework.

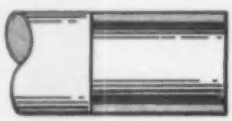


Bearings

LOCTITE Sealant replaced press fit, opening up tolerances .002 inch on shaft and housing. Rejects were cut from 8% to 1% and rework from 20% to 0! Bond to inner race withstands 1000 lbs. thrust ... equal to the best press fit. Slip fit with LOCTITE gives more uniform retention ... eliminates fretting damage due to loose "press fit" or bearing distortion resulting from tight press fit ... assures better shaft alignment. Easier tolerances speed assembly.

Hardened Sleeves

Eliminates shrink fit ... mounts hardened sleeve without pulling temper.



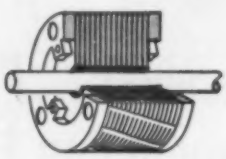
Gears and Pulleys

Eliminates broaching, knurling, shaft distortion. Easier gear replacement.



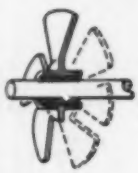
Rotors

Eliminates shaft distortion and resulting regrinding & straightening.



Fans

Eliminates set screws ... no amount of vibration will loosen part.



LOCTITE Sealant is easy to apply... simple to automate

LOCTITE is a one-component liquid with the unique property of converting to a tough plastic when confined between close fitting metal parts. It does not air dry. It does not require mixing with a catalyst and will not spoil on standing in a storage vessel. It comes fully prepared ... stores for years ... hardens only when treated parts are assembled. It forms a tough seal that resists heat, oil, water, all common solvents. Parts treated with LOCTITE can be disassembled by ordinary methods.

LOCTITE Kit No. 10-10

Contains 10 grades of Loctite Sealant specially put up to assist designers in determining proper grade and use of Loctite in product development and for general experimental work. By selection of proper grade, the designer can apply a predetermined amount of locking torque.

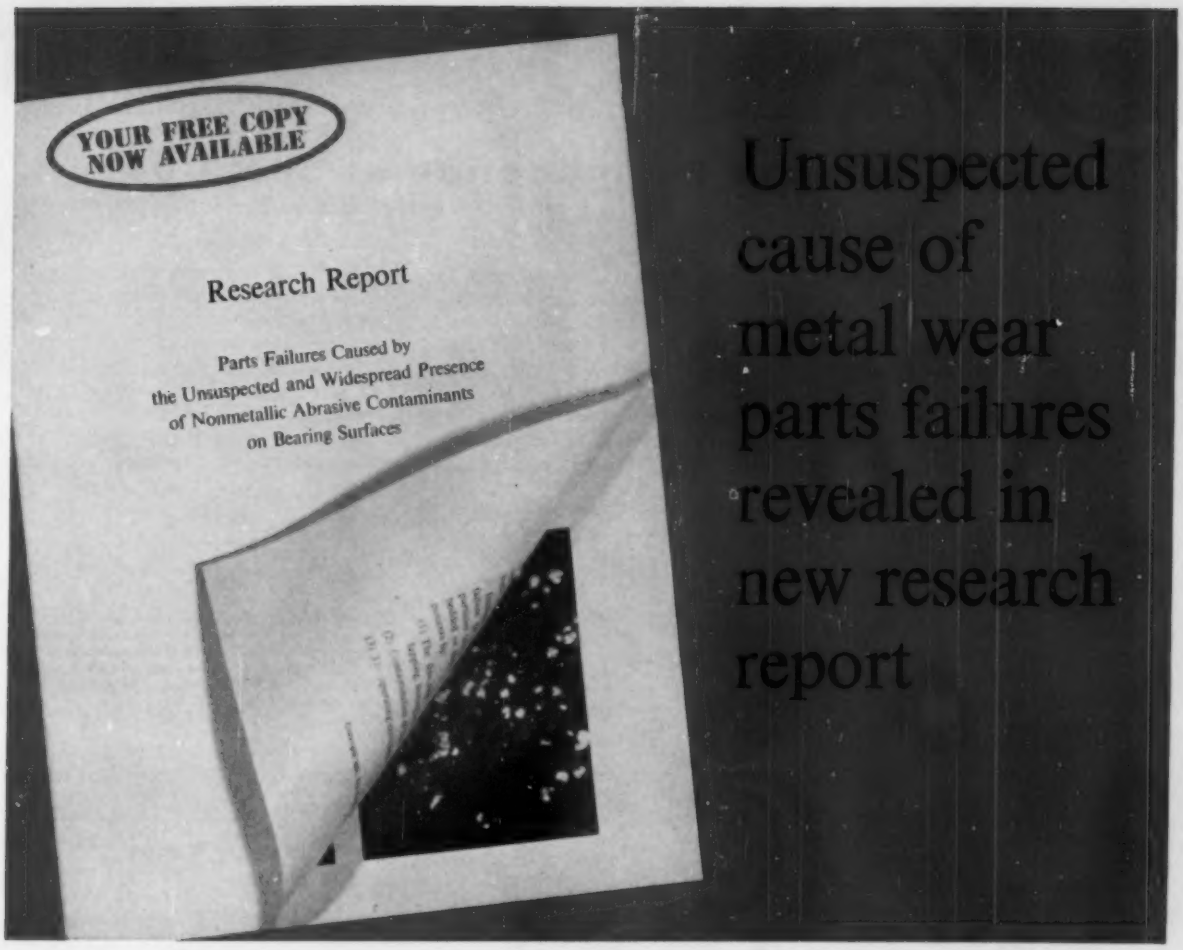
Write for literature and free sample capsule.



LOCTITE® SEALANT

AMERICAN SEALANTS CO. 111 North Mountain Road, Hartford 11, Conn.

Circle 303 on Page 19



...two-year study establishes microscopic abrasive particles as principal cause of erratic performance and premature failure of bearing surfaces

In this exhaustive analysis of more than 8000 new and failed precision components, 81% of failures have been definitely traced to the presence of nonmetallic abrasive particles introduced by finishing operations, as well as through contamination of lubricants, and by the operating environment.

The study established that these particles cannot be detected by commonly used microscopic inspection techniques . . . nor can they be removed by ultrasonic or conventional cleaning procedures.

This dramatic report details research, documents results, and offers recommendations for eliminating this hitherto unsuspected cause of failure. It may be the complete answer to your critical reliability requirements.

MAIL COUPON FOR YOUR FREE COPY

THE Electrolizing COMPANY

Division of Advance Industries, Inc.

1505 East End Avenue • Chicago Heights 5, Illinois

Other Plants Located at:

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Please send your new Research Report without cost or obligation.

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Circle 304 on Page 19

Spaulding FIBRE FACTS FOR ENGINEERS NUMBER 5

How to Achieve Permanence at Low Cost

by K. H. Alverson, Product Standards Director

Seldom is a high degree of permanence found associated with the characteristics of dielectric strength, rugged structural strength and arc resistance at such low cost as in Vulcanized Fibre. This permanence and strength allows the engineer to use Vulcanized Fibre to replace more expensive plated or coated parts even where insulating or arc resisting properties are not required.

The reason for Vulcanized Fibre's agelessness lies in the chemical action of its production which arrests the natural tendency of cellulose to deteriorate. This renders Vulcanized Fibre more stable than the hardest wood. (Corrosion, such as attacks metals, is completely precluded since Vulcanized Fibre has a non-mineral base.)

The permanence of Vulcanized Fibre in use is well illustrated by its application as insulation in transformers, switchgear, and circuit breakers. Parts such as corrugated duct spacers, arc chutes and barriers are subjected to terrific arc exposure and must maintain their form, strength and electrical properties for years under continuous operation in hot oil. Lightning arresters and high voltage fuses, made from Fibre tubing for protecting power line transformers, are still in service and operation, in satisfactory condition, after more than twenty years of use.

Industrial fuses with a fibre case and replaceable fuse link are one of the best known uses for Fibre tubing. If the fuse blows, the link is simply replaced and the fuse case used over and over again.

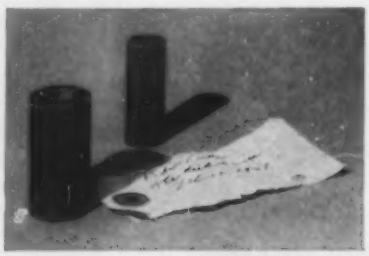
Fibre grommets are used to form a permanent locked-in-place insulator in metal assemblies, such as clocks, motors, etc. They will not deteriorate and fall out as will rubber. Fibre grommets for such applications are approved by the Underwriters' Laboratories.

Fibre is non-corroding, unaffected by oils, greases, solvents, etc. It withstands the pounding of heavy trains when used as track insulation under outdoor exposure. Easily formed into complex shapes for use in athletic equipment, welding helmets, etc., all of which must withstand harsh usage without failure.

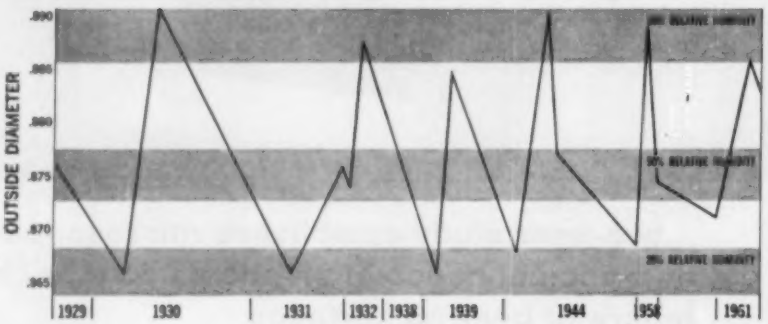
Trunk coverings, sample cases, factory trucks and waste baskets have been made for years of Vulcanized Fibre to take advantage of the light weight, abrasion resistance and permanence of the material.

Because of its many unique characteristics, Vulcanized Fibre offers a virtually endless variety of applications.

Spaulding Engineers who have been trained in Value Analysis can help you take advantage of the wide range of possibilities in designing to reduce costs through the use of Vulcanized Fibre parts. They also make available to you Spaulding's extensive fabricating facilities and experience in working with this extraordinary material.



While many materials deteriorate over the years, Vulcanized Fibre maintains its essential properties for decades. Note how the linen tag attached to Fibre tube samples in 1929 shows age, but Fibre tubes look and act as they did 32 years ago.



Long term test of fibre, which has been going on since 1929, shows that fibre still responds to wide humidity changes in the same way it did when test began. Predictable changes in dimension occur when fibre tubing is subjected to extremes of humidity. Tests such as these prove that there is no change in Vulcanized Fibre characteristics over long periods of time.

Be sure to add this FREE Literature to your reference files. *WRITE TODAY.*



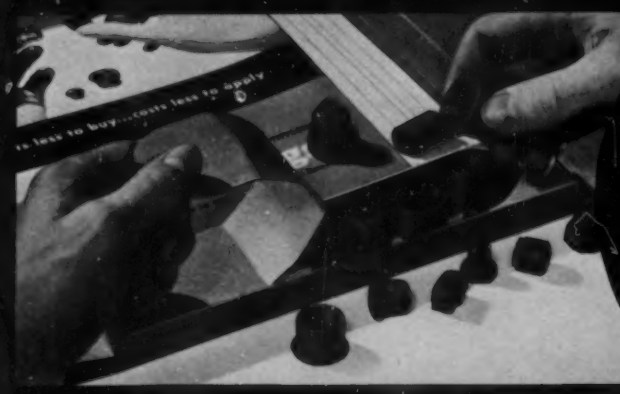
New Value Analysis Brochure a detailed review of the Spaulding Value Analysis technique together with case histories of design improvement and cost reductions that have been accomplished through Spaulding's Value Analysis of customer products. 12 pages.



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Circle 306 on Page 19

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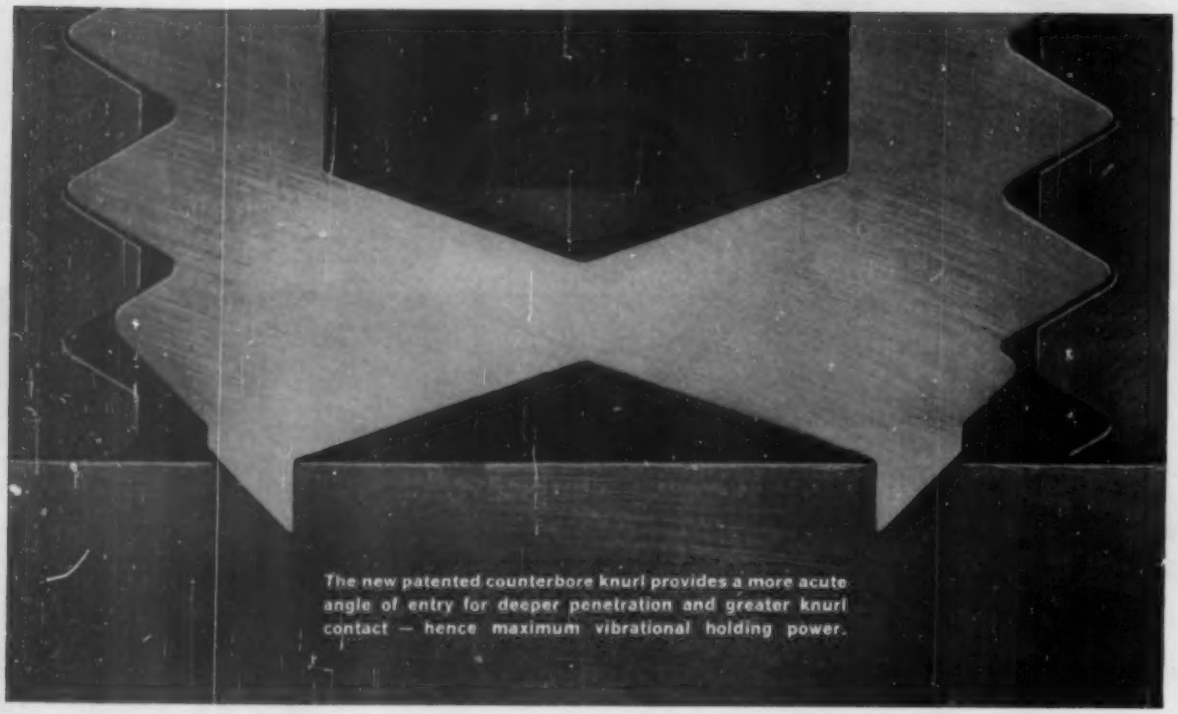
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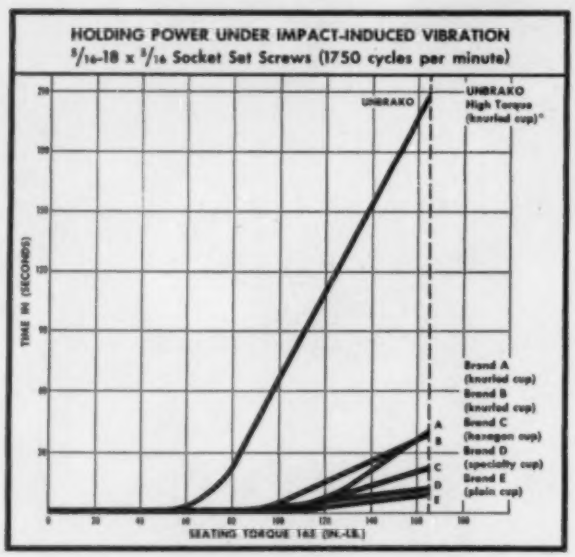
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*No. 2,992,689—patented July 18, 1961 †T.M. Reg. U.S. Pat. Off., The Nylok Corp.

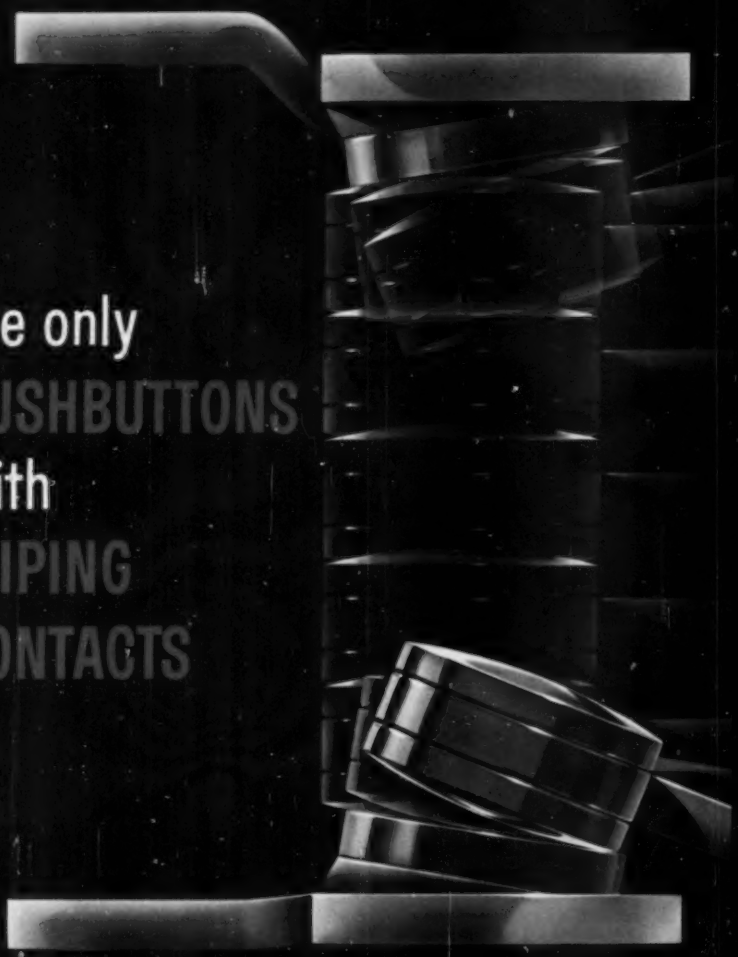
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Circle 307 on Page 19

Circle 308 on Page 19→

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LI'L ABNER by Al Capp

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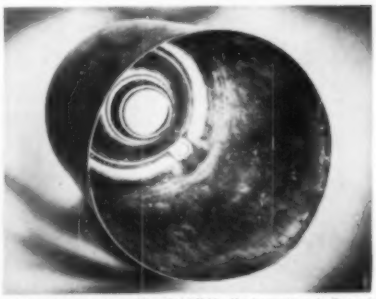




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TRADEMARK

MACHINE DESIGN

November 9, 1961



Trappings of Freedom

THE Big Boss was in rare form. "Engineers give me a pain," he shouted, "now that they're getting bigger paychecks they're hollering for more freedom. A bunch of prima donnas, if you ask me."

The outburst was prompted by the case of some engineers who had been getting careless about their appearance, their work habits, and their observance of established working hours. In an attempt to stall off disciplinary action, the chief engineer had defended his men with a plea for a freer, more relaxed climate in which creative engineering could flourish.

He got nowhere because, in fact, his own men had let him down. Confusing the trappings of freedom with the substance, they had abused the privileges which their professional-minded chief allowed them.

Frequently imbued with the "organization man" complex, top management tolerates nonconformity only if it is a price that must be paid for near-genius talent.

These sloppy engineers could have built up a solid reputation as a team of idea-men reaching for responsibility and for the freedom to organize their own efforts toward greater productivity. If they had done so, the Big Boss might even have looked with indulgence on the eccentricities of "my young Steinmetz's."

What price freedom? In his article overleaf, Gene Raudsepp lists eleven elements of freedom that engineers say they want. Any engineers seeking the freedom to which, as professionals, they feel entitled, might profitably review this list. The elements to go after first, naturally, would be those likely to show tangible benefits to the overall engineering effort.

After all, the trappings of freedom—the personal privileges—must be earned.

Colin Carmichael

EDITOR



"There is more freedom at my present job. I can come and go as I please. There are no time-clocks. In a way, there is an academic atmosphere here, and the pressures of routine are at a minimum."

"In my present job I have found personal freedom of movement and the opportunity to express my thoughts along with the responsibility to execute them."

"In order that engineers can concentrate on their technical problems they should be given complete privacy. I've heard that at one company it is forbidden to call up an engineer during the hours of 9 to 11 a.m., to make him completely free from interruptions."

"In our company there is no freedom or encouragement given to publish papers. I once had a paper ready to go, but was denied the opportunity."

"The supervisor holds too tight a rein on us; the company policies are more generous."

"More freedom should be given to engineering personnel to attend society meetings and symposia on company time."

How Much

EUGENE RAUDSEPP
Director of Psychological Research
Deutsch & Shea Inc.
New York

IN surveys dealing with job satisfaction and dissatisfaction, engineers emphasize "more freedom" so often that freedom alone would seem to guarantee increased output and high job satisfaction. But, like most issues involving people and personalities, there are no pat answers to the problem of engineers' freedoms. Together, management and engineers themselves must steer a course between too much and too little.

Should Freedoms Be Limited?

Freedom is important, of course, when it contributes alike to engineers' performance and self-development. But the exaggerated degree of freedom indicated in many engineers' comments is unrealistic. Absolute freedom would be downright harmful to engineers and their companies.

Absolute freedom was tested recently at Kimberley-Clark Corp. A group of individuals, representing diverse fields and backgrounds, was given complete freedom on what to work on. There was no defined responsibility for any particular area of the company's activity, and the group was not subject to any of the regulations that apply to the rest of the employees in the company. They were even given their own bank account, their own laboratories, and their own machine shop.

How did the members of the group react to this

Freedom for Engineers

The amount of control which management exerts on engineers should depend on the purpose of the engineering organization and the caliber of the engineers. Where control is tight, there may be a case for relaxation—within limits. This article tells how engineers view on-the-job freedom and what engineering management can do to relax controls—without losing control.

complete freedom? As William G. Wilson, a member of this group, reports, "Their anxiety rose and was manifested in such statements as, 'We aren't as free now as we were before.' What they meant was that they were now experiencing a new kind of responsibility—the responsibility to set limits and direction on their own freedoms rather than have their freedom limited by the organization. Another way in which they showed their anxiety was to continually argue about the question: 'What shall we work on?' "

Wilson continues, "Our anxiety rose to tremendous heights. However, as a group we came to the realization that we had to limit our freedom. This was true regardless of what we worked on. . . . We finally learned that the very essence of our freedom was our ability to limit its scope."

Many management people still react to most engineers' demands for more freedom in a perplexed and negative fashion. In a recent study by Opinion Research Corp., one manager put it, "I feel the freedom often referred to is actually a form of laziness. Too many people want to do what they want, when they want, and how they want, with no regard to the over-all effect this has on the company. The place for such freedom is in acadamic institutions, not competitive industry."

J. R. Pierce, director of research communication principles at Bell Telephone Laboratories, reports, "We all know people who come around with a wonderful new idea every month, week, or day (maybe it just seems like once a day). I don't believe that even a great genius has that many ideas worthy of his serious effort.

"The man with an idea a day is unlikely to do anything substantial about any idea. He may become disgruntled because he cannot force others to work on his ideas, or he may unhappily work on one idea and bemoan the tyranny of the world in general. In no case is he apt either to make himself happy or to enrich the world.

"The idea-a-day man is apt to be irresponsible concerning his ideas. He hopes that someone else will nurture them from bare existence into viability in a world of ruthless competition. Indeed, the chronic begetter of ideas may become angry when no one else gives his offspring the attention he is unwilling to lavish on them."

What Freedoms Do Engineers Want?

What do engineers really mean when they talk about "more freedom." From analysis of recent studies, the following elements of "freedom" are:

1. Engineers want to manage their own work.

They want to use their own approaches in solving problems, to work on their projects in their own

style and at their own pace. They resent close or detailed direction from management and supervision. They are oversensitive to control and they do not like to feel that they are being manipulated or unduly restricted in discharging their functions.

Freedom to manage his own work shows to an engineer that his supervisor has confidence in his ability and judgment. This attitude can be one of the strongest energizers and motivators to increased output. Quite often, of course, an engineer's work involves a specialty where the supervisor's grasp is not as deep or thorough. In this case, it is quite normal that the engineer proceed on his own.

Many supervisors still say that engineers want too much freedom and responsibility, and they want it too soon. Supervisors also point out that those engineers who complain most vocally about overcontrol and overdirection are frequently the men who have demonstrated in the past their ineptitude when left completely to themselves.

2. They need freedom to do the job well, according to their own high standards.

They resent having to tamper with their technical integrity to satisfy short-range commercial interests.

3. They want to complete a job once undertaken.

They resent being shifted from one incomplete project to another. They want to follow through and see how their ideas are working out in concrete form.

4. They want to spend part of their working hours on problems of their own choice.

Especially, research engineers desire to pursue projects of their own choice, not necessarily those wanted by management. Research engineers want freedom to do creative work, to develop their own ideas, and to extend their skills and talents.

It is palpably obvious, however, that if all engineers were given the freedom to choose problems to work on, many of them would feel lost. Probably a good many engineers are happy to work on problems indicated by supervisors. Not every engineer is capable of choosing important problems to work on, but this does not mean that he lacks ability to work out problems suggested by others. Freedom to choose problems assumes major importance when an engineer has been forced repeatedly to work on something completely alien to his interests, skills, and background.

5. They want to participate in decision-making, especially where it involves their own work.

Traditionally, authoritarian management has felt that decision-making is its prerogative and that the individual engineer, as one manager recently put it, "exchanges his full freedom of action for his place on the company payroll." In recent years, however, management has come to realize that it is to everybody's advantage to incorporate into its administrative structure more of the democratic process with its emphasis on participation and representation in

How To Keep Creative People Creative

1. Welcome and encourage constructive nonconformity, initiative, individuality, and diversity.
2. Allow as many engineers as feasible to have part in decision making and in the formulation of long-range plans. Especially the more creative members of the technical staff need to have voice in decisions that affect them.
3. Provide personal recognition for accomplishment, and deliver adequate, concrete rewards for each accomplishment individually. Augment the importance of the individual engineer rather than his group.
4. Allow more freedom in the work milieu and freedom for individual engineers to guide their own work. At the very least, provide them with specified and formally agreed-upon areas of freedom and self-direction. Increase these areas gradually if evidence of growth in maturity and self-reliance warrants it.
5. Keep the organizational structure flexible in order to cope with emerging change and new problems.
6. Encourage interchange of information and opinion among groups and departments, but with freedom to follow individual leads contrary to group ideas, if the engineer feels that his approach furthers the project better.
7. Consider individual personalities in making assignments, picking leaders and supervisors. Actively seek out, develop and encourage those with special talents and aptitudes. Tangibly reward excellence and extra effort, and establish special incentives for the "achievers."
8. Lead and enthuse by suggestion and indirect persuasion, rather than by specification or command.
9. Provide opportunity for variety of experience, change, and learning, and allow individual engineers a chance to try their occasional pet ideas without premature criticism.
10. Recognize differences in individuals. Have a keen appreciation of the characteristics of each individual, his strengths and his weaknesses. Treat each individual engineer as a person of worth in his own right. Omit superficial backslapping joviality and replace it with sincere concern for each engineer's growth and development.
11. Organize special, experimental groups where deviate thinking, constructive nonconformity, and originality becomes the main goal. Allow them access to all departments and divisions of the organization.
12. Make groups aware, through lectures and special communications, of the pressures they bring on individuals to conform. Remember that there is enough conformance built into the human species as the result of the process of growing up and that relaxation of rules won't necessarily result in chaos, anarchy, or nihilism.

decision-making. Many engineers have shown that they can exercise self-direction and self-control to a large degree, provided they feel committed to the organizational and project objectives.

There are some skeptics, however, who insist that the practice of engineers' participation in decision-making is merely a placating device and that when important decisions are made they are made unilaterally by management. Thus, Eugene Emerson Jennings of Michigan State University recently stated, "Even the practice of coming to the point of appearing to give lip service and some degree of credence to the democratic approach in such things as decision-making and policy formation represents, for the executive, a stretching beyond his psychological capacity."

Why So Much Power in Organizations?

Why is such a high value placed on the ability of individuals to conform to the edicts of the group? Aside from such matters as controls and the desire for predictability, group activity is favored because it appears democratic and affirmative. It assuages private doubts about one's capacity to make individual decisions, and it lifts the burden of responsibility from any one individual's shoulders.

Group activity is also favored because it relieves management of the task of punitive policing by imposing the group's inherent discipline upon individuals. But as Crawford H. Greenewalt, president of Du Pont, has pointed out in his book *The Uncommon Man*, "The hazard is that the very pressures within the group which hold the scoundrel in check will impose upon the individual restrictions which stifle the creative urge and the zeal for personal achievement. . . . Anything which inhibits the individual in expressing his own particular personality serves to deprive the organization of initiative. Our problem is to keep alive the powerful stimulant of individual thought at all levels and in every phase of our effort. Unless we do, we run the risk of making a displaced person out of the Man with the Big Idea."

Groups actually punish deviate members. This has been shown in many psychological experiments. In one, Dr. S. Schachter of the University of Michigan set up a group of nine members of which three worked with the experimenter. One person, labeled the "mode," took a position on the issue being discussed which agreed with the majority and stayed there. The second person, the "slider," took initially an extreme position on the issue but adopted the majority view part way through the discussion. The third person, the "deviate," took an extreme position and refused to change it.

After the discussion, the group was asked to nominate an executive committee for policy making and a correspondence committee to handle housekeeping details. The "deviate" received almost no nominations to the desirable executive committee and he received more nominations than others to the undesirable correspondence committee. He received, in addition, the lowest rating when the group was asked to name "the most desirable member of the group."

6. They want freedom to make mistakes and not be held accountable for every action and idea at every moment.

Engineers don't want to be penalized for a suggestion or idea that does not work out if they have honestly and energetically tried to make it work. Fear of consequences effectively undercuts the ability to produce ideas in the first place.

7. They want more flexible working hours and freedom to come and go at irregular hours.

They want their work-schedule not enforced upon them too strictly. They want preferential treatment and not have all rules and regulations of the nonprofessionals imposed upon them.

While some companies do not hold engineers strictly to stated working hours, most companies would not allow engineers to determine when they can come or go. Most companies, however, allow engineers occasionally to take care of personal affairs during normal working hours.

8. They want freedom to relax occasionally.

They don't want to feel that supervisors might think they are loafing. They need freedom from distractions and routine, nonengineering work.

9. They want to discuss their ideas and consult with others in the engineering community.

Sharing of ideas with others gives them an added measure of personal recognition. They also need freedom to consult their supervisors whenever necessary.

10. They want to publish the results of their work.

They want to present papers at professional meetings, and to gain recognition for their achievements.

11. They want freedom to extend their education.

Engineers want to take educational trips, and to attend professional meetings on company time. They want freedom to go to a library whenever they need to, and to read technical journals on company time.

They want to extend their background by diversified experience in a variety of areas. The greatest present danger is the tendency of a narrow field to become obsolete in the course of rapid technological advance. If an engineer lacks breadth of knowledge or intellectual competence to readily shift to other fields, his freedom and very livelihood are at stake.

Must Engineers Be Good "Mixers"?

It is no secret that engineers are one of the most dissatisfied groups of employees in industry. Perhaps one of the main reasons is that they lack the passion for anonymity required from an "organization

man" or a "team-member." Management is also seen by many engineers as exercising too much control over the environment they have to work in, and over their destiny as professional people.

In a recent survey by Opinion Research Corp., participants were 622 engineers and scientists. Findings were: 76 per cent felt that management tries to manipulate people for its own purposes; 77 per cent felt that engineers' and scientists' talents are poorly utilized by management; 61 per cent felt that management does not provide enough freedom to allow the true creativity that they expect from engineers and scientists; 76 per cent believed that engineers work best in an atmosphere free from pressure; and 64 per cent felt that they do their best work when they work alone.

High technical aptitude and creative brilliance have been considered secondary to the ability to be a "good mixer" who easily adapts to the tacit as well as the formal rules of an organization. The creative engineer or scientist who showed some idiocyncracies was either coerced to conform to these rules or subtle pressures were brought to bear upon him to leave the company. For a long time, organizations either unwittingly or deliberately induced dependency feelings in their technical people so that the number of those who remained creative dwindled radically.

Fortunately, many companies are beginning to realize that heterogeneity is essential to progress, and that constructive variability is the most valuable resource they could have. In view of this, several organizations are ready to risk hiring a few individualists and mavericks to pump fresh blood into the organization. They realize that engineers who are not afraid of their uniqueness bring with themselves different viewpoints for the solving of problems. Further, they know that a maverick engineer's ideas may force other engineers to shake loose from their habitual ways of scrutinizing projects and procedures. And this, by contagion, would eventually revitalize all levels of technical personnel.

How Can Companies Relax Controls?

Organizations must become more flexible, more relieved by individual freedom and autonomy, more responsive to the needs that bring forth self-reliance and initiative. They must find means of combining a greater degree of individual initiative with organizational goals, and lessen the degree of externally imposed discipline and cohesion.

As David McCord Wright has pointed out, a smoothly functioning, highly co-operative organization can actually weaken organizational vitality. "Successful administrators should remember that sometimes it is desirable for a person to be insubordinate and difficult if he has really valuable ideas to contribute. An administrative fallacy runs through modern American thought, creating a danger of anesthesia. The world which may develop is one of cozy, unchanged units with plenty of 'co-operation' but not much action."

Professor W. W. Haynes of the University of Kentucky advocates a "challenge and response approach to managing." This approach asserts that people are more productive and effective when granted sufficient autonomy and wide enough scope to make their jobs interesting and challenging. It claims that the "light touch" in supervision will evoke initiative and a high sense of responsibility. The assumptions underlying this approach, according to Professor Haynes are:

1. People want to work, and work best when not watched closely.
2. The errors that might be avoided by guidance from above are less costly than the harm done.
3. A constant flow of innovation is imperative, and autonomy is conducive to innovation.
4. There is a tremendous pent-up supply of talent waiting to be released if the challenges are applied.

The ability to bring about important results, progress, and creativity can be increased in companies if more power is delegated to individual engineers and scientists and to smaller groups where the individual is not overwhelmed by impersonal vastness or mere numbers. In addition, management should consider fitting systems to technical personnel rather than personnel to systems, and create a new organizational philosophy which allows more scope for individuality and individual development, especially where the more creative engineers are concerned. As Douglas McGregor puts it, "We can improve our ability to control only if we recognize that control consists in selective adaptation to human nature rather than in attempting to make human nature conform to our wishes."

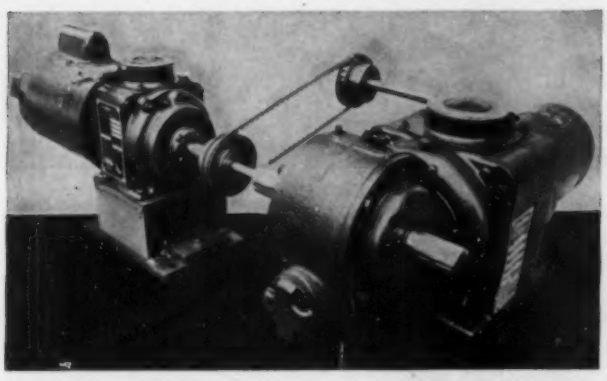
The desirability of encouraging more independence, more constructive nonconformity, more individuality and more autonomy depends, of course, upon the basic purposes and objectives of the company. A company engaged in routine manufacturing operations can use a tightly organized approach. A company which can assure its continued existence only through rapid growth, constant change, and creativity has to favor more individualistic approaches. Different combinations of approaches should be adopted, depending on the function and quality of technical personnel employed and the objectives of each department. The important point is that individual engineers and groups of technical personnel require individual treatment.

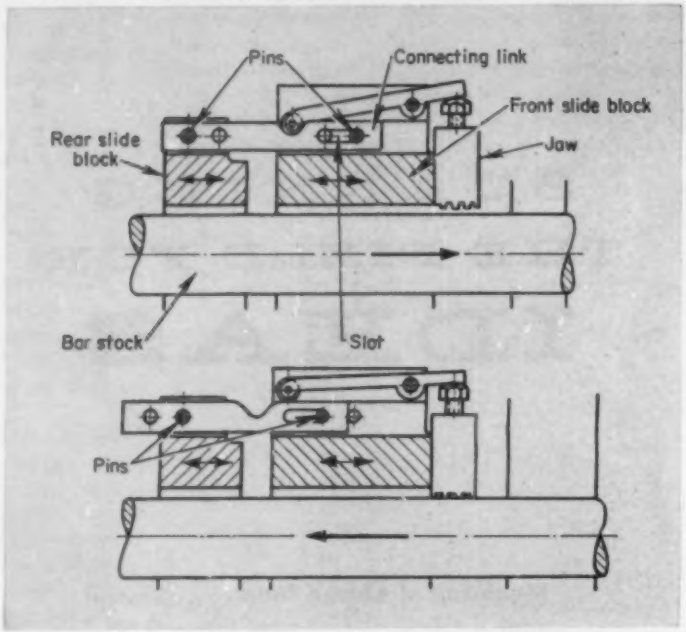
Change in the direction of responsible, constructive independence, self-control, and self-direction will require: First, extensive modification of the attitudes of both management and technical personnel. Second, a gradual and determined translation of the new attitudes and policies into constructive action.

By giving freedom in some areas, management shows that it has confidence in the engineer's ability and judgment. As pointed out before, however, many engineers need constant guidance and assistance from the supervisor. It falls upon the supervisor to recognize which of his people need and can handle more freedom.

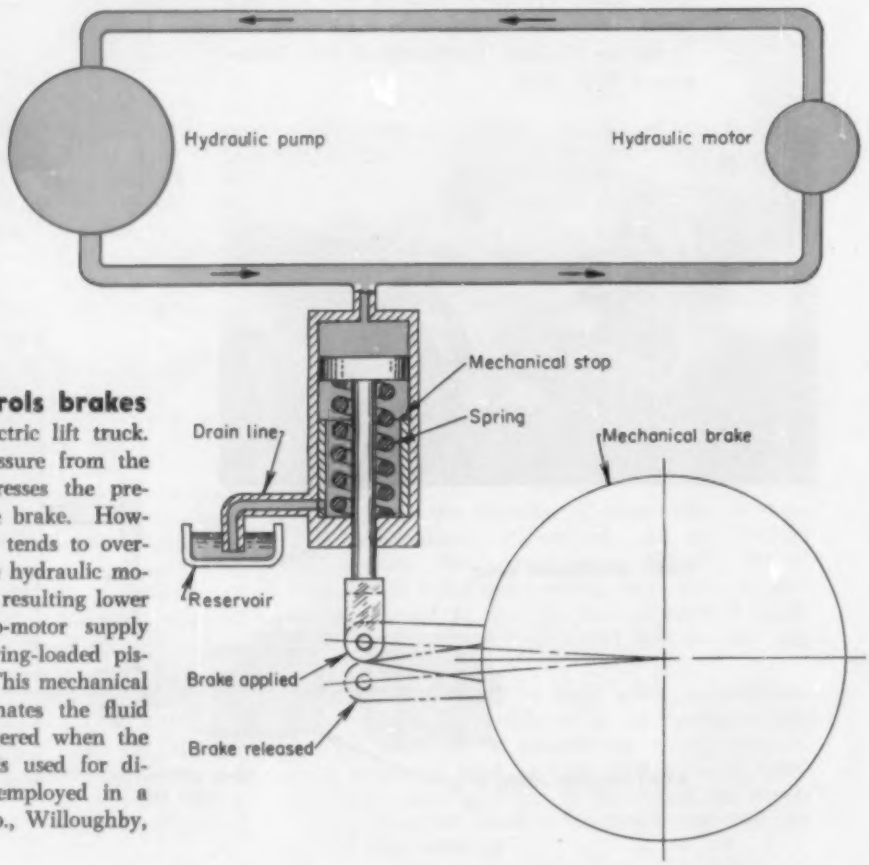
SCANNING THE FIELD FOR IDEAS

Mechanical closed-loop controls output speed of a large variable-speed drive. A small differential-gear set measures difference between output speed and a reference speed. This error signal actuates the control shaft of the large variable-speed drive. A small variable-speed drive provides control of the reference speed. Principle employed in a speed-control system by Graham Transmissions Inc., Menomonee Falls, Wis.

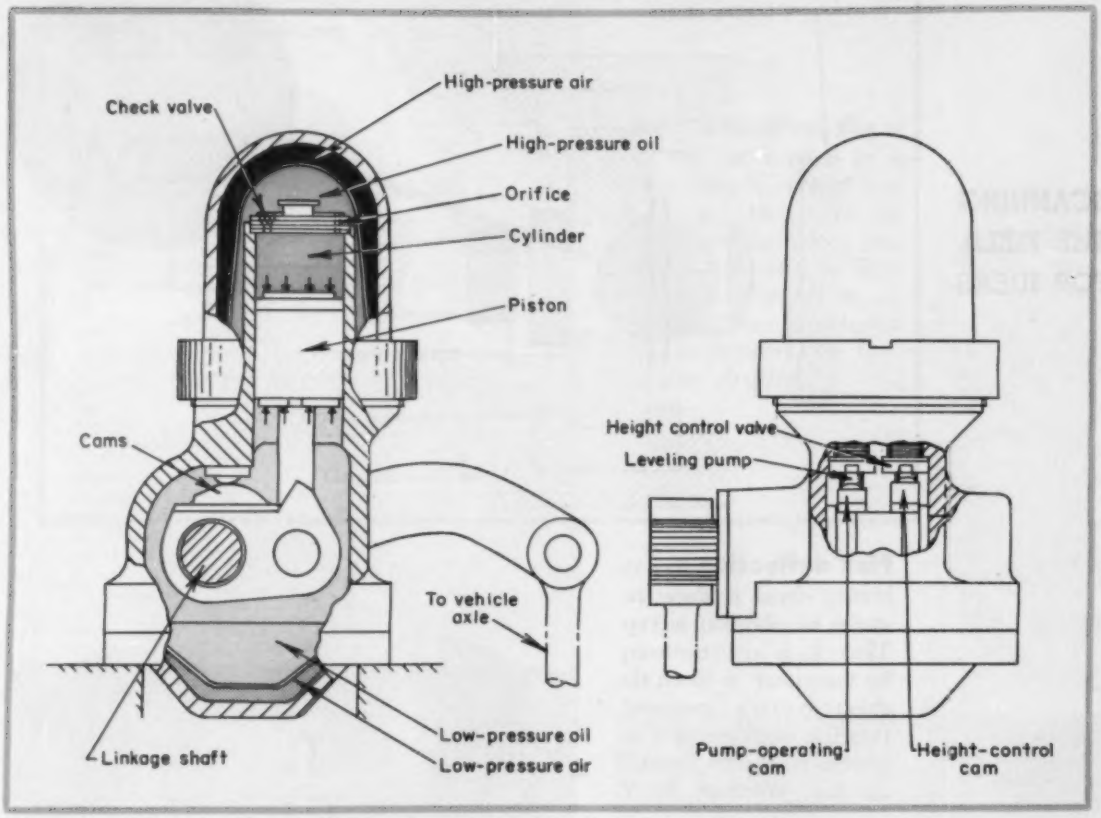


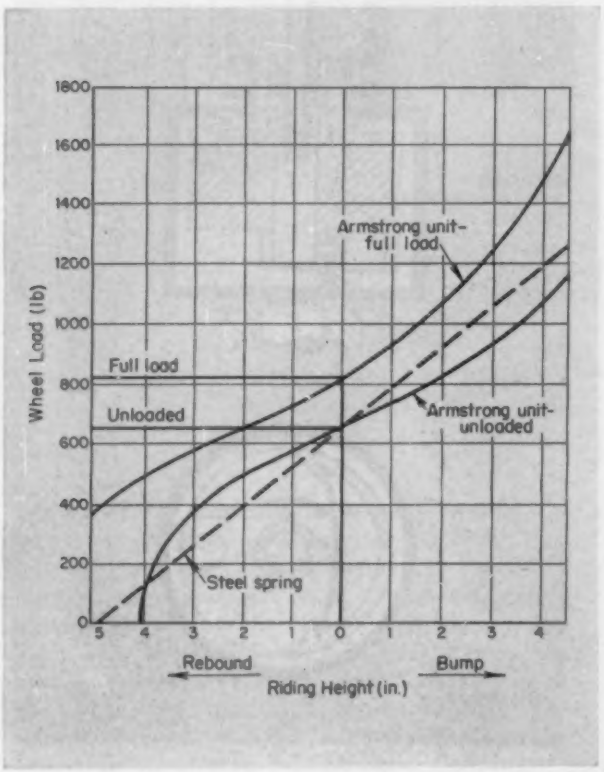


Alternate pin locations control output-motion direction of a bar stock feeder. Uniform reciprocating motion of the rear slide block drives the front slide block through a slotted connecting link. A notch in the top surface of the link serves as a cam to actuate jaws which grip the stock. Thus travel direction of the barstock is determined by the timing of the closed-jaw portion of the cycle. Principle employed in an automatic lathe designed by Manufacture de Machines du Haut-Rhin, Haut-Rhin, France.



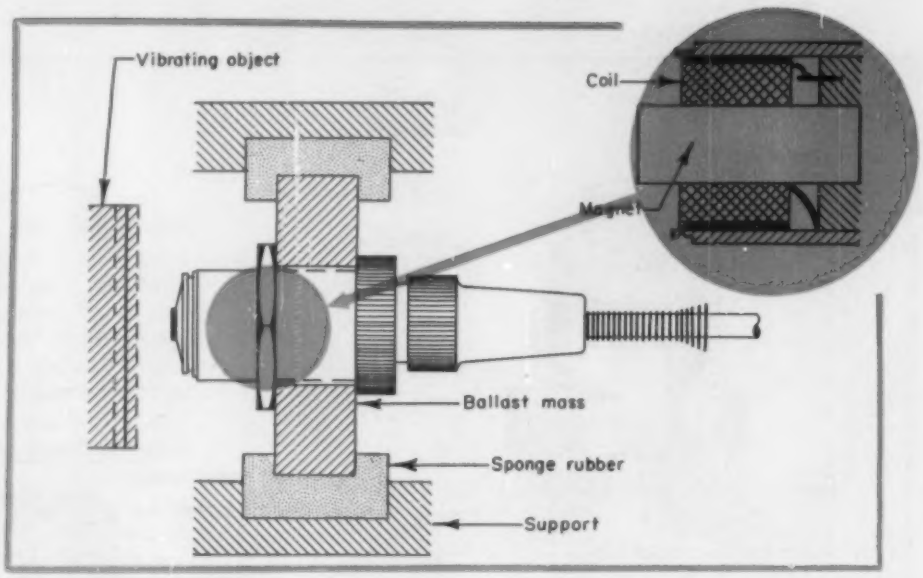
Back-pressure controls brakes in a hydrostatic-drive electric lift truck. In normal operation, pressure from the motor supply line compresses the preload spring to release the brake. However, whenever the truck tends to overrun the power source, the hydraulic motor acts as a pump. The resulting lower pressure in the pump-to-motor supply line then permits the spring-loaded piston to apply the brakes. This mechanical brake arrangement eliminates the fluid heating problems encountered when the hydrostatic transmission is used for direct braking. Principle employed in a lift truck by Heifred Corp., Willoughby, Ohio.



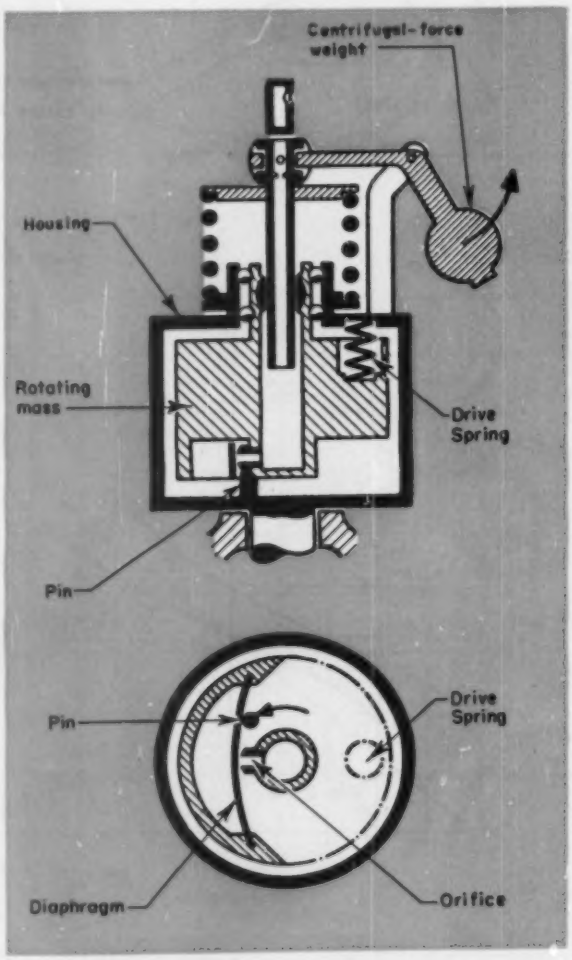


Self-powered air spring uses vertical travel of vehicle wheel to provide a self-contained unit. A piston, linked to the vehicle axle, is constrained by an oil and air accumulator on each side of the piston. Differential pressure in the upper chamber normally supports the load of the vehicle. Upward motion of the axle forces oil from the cylinder through a check valve into the upper chamber. During downward travel of the axle, oil is forced from the upper chamber, through an orifice, into the cylinder. Two cams on the linkage shaft control the self leveling in response to vehicle load changes. When the vehicle load is increased, the piston moves upward. Once the vehicle is in motion, however, small vertical movements of the wheel over irregularities in the road surface are transmitted to one cam which operates a small piston pump to transfer oil from the lower to the upper chamber. When the vehicle load is decreased, the second cam opens a valve to permit transfer of oil from the lower to the upper chamber. Self-powered spring used in vehicle suspension by Armstrong Patents Co. Ltd., Fulford, York, England.

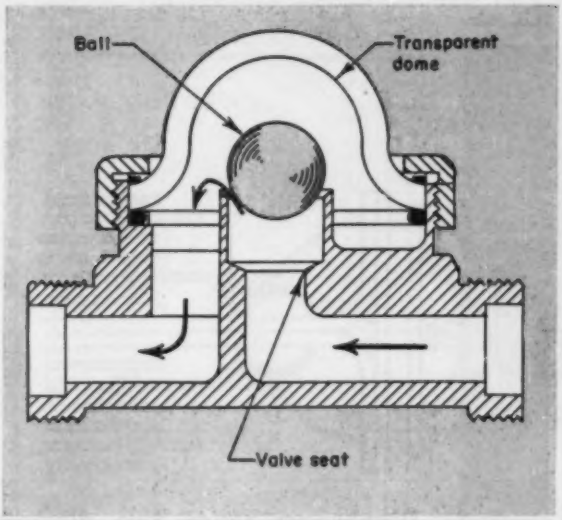
SCANNING THE FIELD FOR IDEAS



Flux deflection by a vibrating object produces response in vibration pickup. Thus it is not necessary for the pickup to touch the object being measured. Principle employed in a vibration pickup by Korfund Co. Inc., Westbury, N. Y.

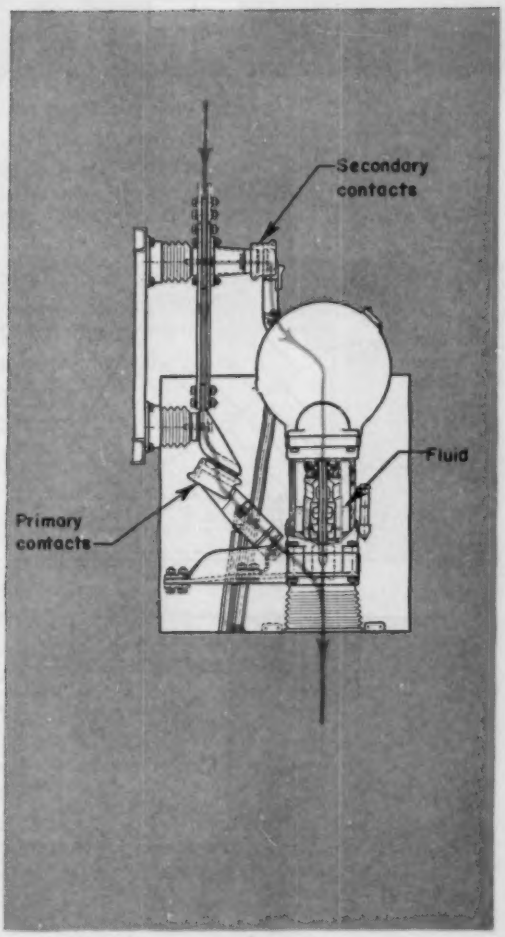


Acceleration positions diaphragm to control air pressure in a governor counterbalance cylinder. Acceleration beyond a preset value controlled by a drive spring produces relative motion between a rotating mass and the governor housing. A pin attached to the mass then forces the diaphragm away from an orifice in the counterbalance cylinder. Principle employed in a turbine governor by Escher Wyss, Zurich, Switzerland.

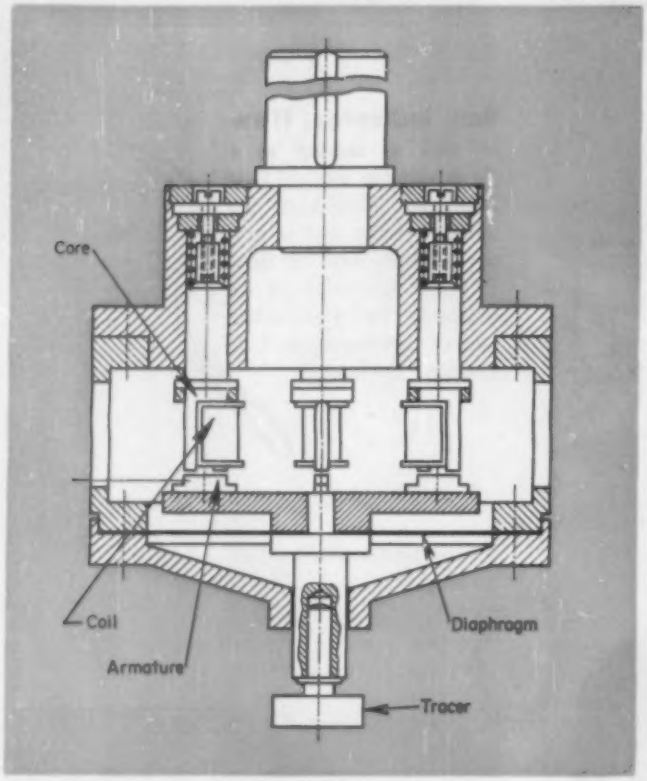


Ball indicates flow as well as serving as a check valve in a visual flow indicator. Height of the ball above the seat is proportional to rate of flow. Principle employed in an indicator by Parkinson Cowan International Ltd., London, England.

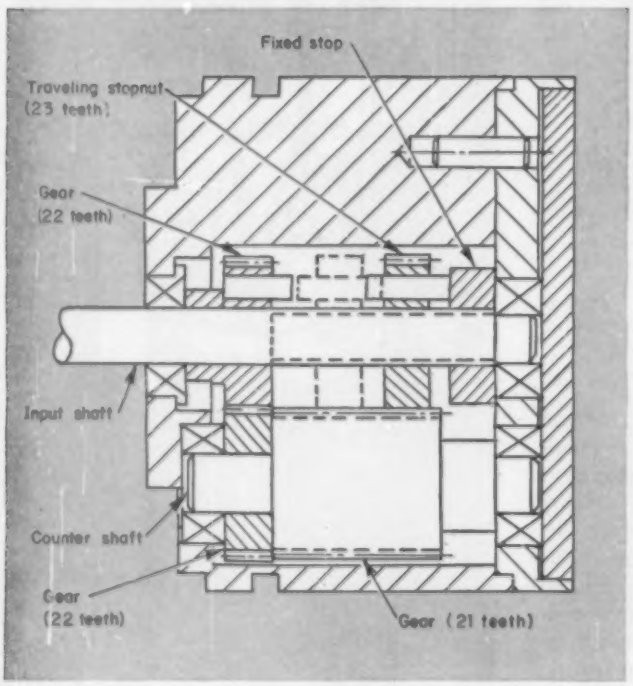




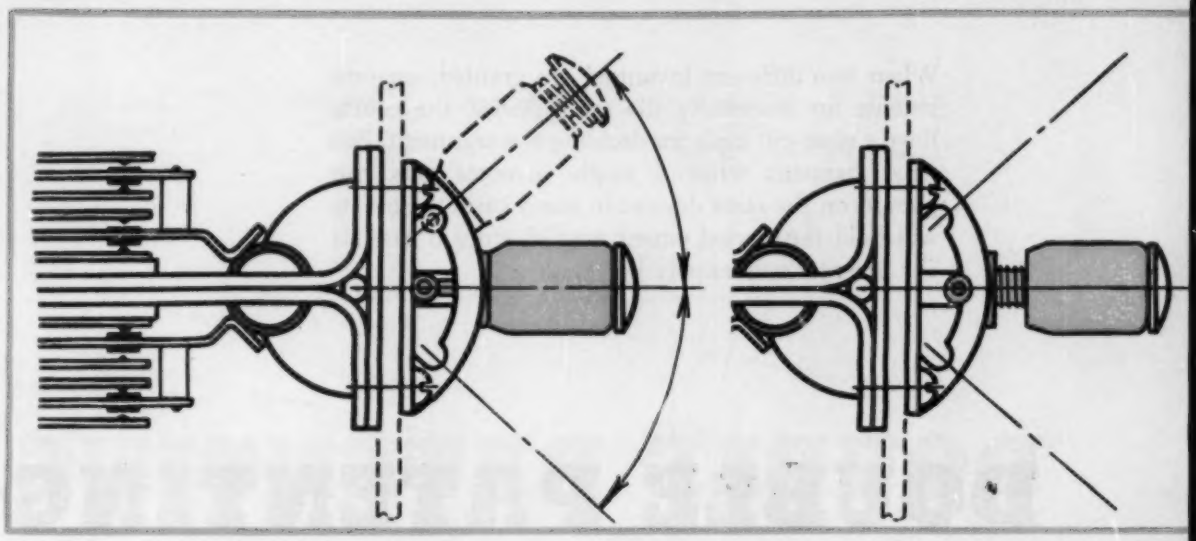
Switch fluid vaporizes to disconnect without arcing. In the closed position, current flows in parallel through primary contacts and through secondary contacts and a conductive liquid. When the primary contacts are opened, the current surge through the other branch vaporizes the fluid, thus opening the circuit. The secondary switch then opens to prevent the circuit from being closed when the vapor condenses. Principle employed in a power switch by Siemens-Schuckertwerke AG, Erlangen, Germany.



Diaphragm reads two dimensions in a tracer head. Armatures mounted on the diaphragm control the flux paths of four electromagnetic pickups, mounted 90 deg apart. Thus, any movement of the tracer finger in either the *X* or *Y* direction deflects the diaphragm and changes the corresponding flux paths of the *X* or *Y* electromagnets. Principle reported in *Stanki i instrument* magazine, Moscow, USSR.

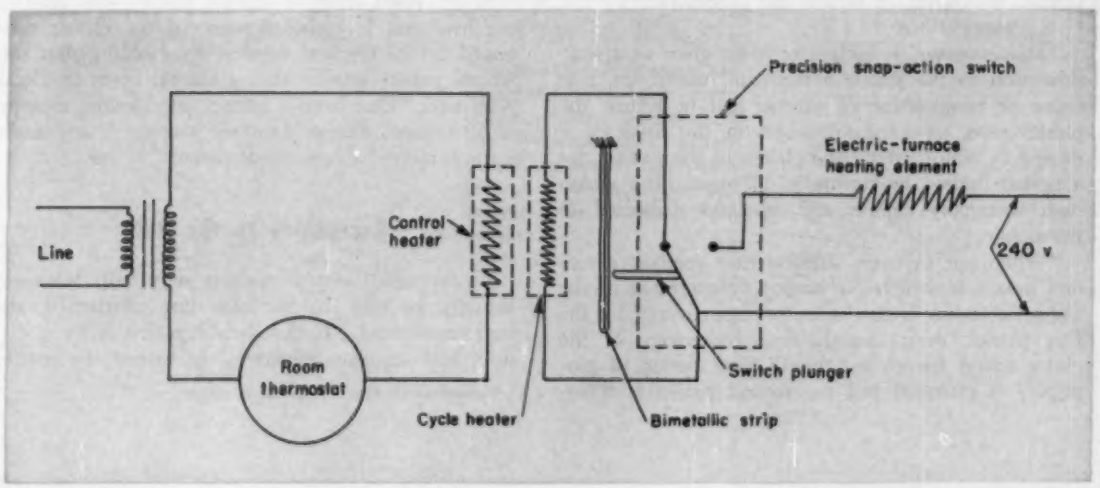


Countershaft rotates stop nut to provide short linear travel. A small speed differential between the main shaft and the traveling stop nut advances the nut in proportion to the differential speed, rather than in proportion to the actual speed of the shaft. Principle employed in a mechanical limit stop by Dynamic Gear Co. Inc., Amityville, N. Y.



Knob doubles as lock for a lever switch. Depression of a thumb plunger permits movement of the actuator knob between detented positions. When the knob is screwed out against the plunger, the detent is locked into position. Principle employed in a lever switch by Switchcraft Inc., Chicago, Ill.

Heaters modify cycling of an electric home furnace to prevent overshoot of room temperature. The bimetallic strip, which actuates a precision snap-action switch, is controlled by two heaters. The cycle heater, which provides only a portion of the heat necessary to operate the bimetallic strip, is on whenever the furnace heating element is off. The control heater, which provides the remainder of the heat necessary to operate the bimetallic switch, is on whenever the room thermostat drops below the preset temperature. Since the cycle heater is turned off when the furnace heating element is on, the bimetallic strip soon cools enough to open the switch. This type cycling continues until the control heater alone produces sufficient heat for the bimetallic strip to hold the switch closed. Principle, in a Westinghouse home furnace, employed in a control by Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.



When two different inventors are granted separate patents for essentially the same device, the courts have a clear-cut basis for deciding the argument. But what happens when a single inventor gets two patents on the same device? In many cases the courts will hold the second patent invalid, since it extends the inventor's monopoly by . . .

DOUBLE PATENTING

ALBERT WOODRUFF GRAY
Forest Hills, N. Y.

TWO patent applications for the same mathematical formula for an airfoil were filed by an inventor four years apart. And two separate patents were issued—eight years apart.

The U. S. Court of Claims held the second patent void. It said of this double patenting, "A patent is a contract between the inventor and the public, the terms of which are formulated by the U. S. Patent Office.

"The inventor in such a contract gives as a consideration to the public a new and useful art, machine or composition of matter and in return the public gives as a consideration to the inventor a monopoly expressed by the claims of the patent, for a period limited by statute to 17 years, after which such monopoly expires and becomes dedicated to the public.

"Where an inventor subsequently receives a second patent in which the monopoly expressed in the claim or claims is the same as that covered by the first patent, even though the phraseology of the claim differs therefrom, the 17 year period of monopoly is extended and the second patent is therefore void because of double patenting, the inventor's rights having been exhausted by the first patent."[1]

In 1931, a patent was issued for the use of piezoelectric crystal to control the frequency of an oscillating system, together with claims for the combination of a radio transmitter and receiver in which such a crystal might be used.

Seven years later, a second patent was granted the inventor. It included some of the claims contained in the original application. Holding that this second patent was invalid, a federal court in Delaware said, "One cannot extract an essential element of his invention from a former patent . . . and make it the subject of a subsequent patent."

Exceptions to the Rule

An apparent double patent may not, however, actually be one. In the case just mentioned, the court continued, "If the second patent is for a distinct and separate invention, or to put the matter

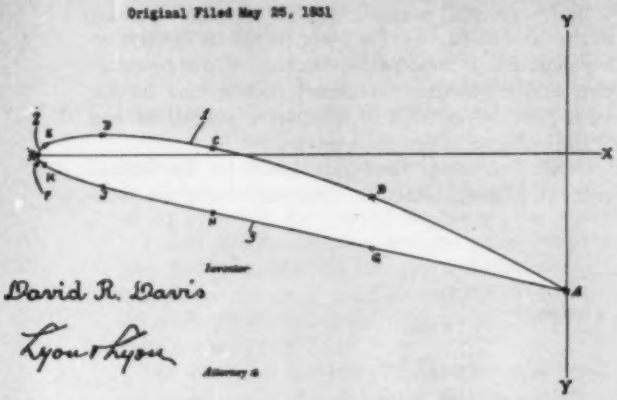
[1]References are tabulated at end of article.

Circle 23-3 on Page 19 for extra copy.

Jan. 9, 1934. D. R. DAVIS 1,942,688

FLUID FOIL

Original Filed May 25, 1931



David R. Davis

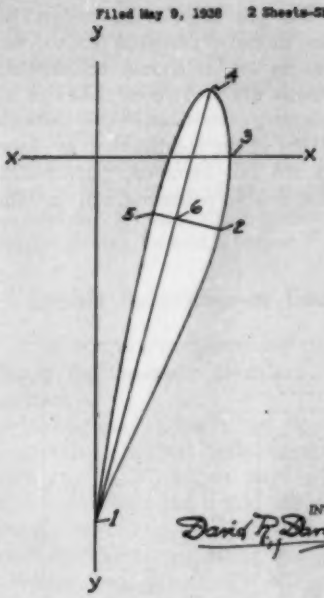
By Lyon & Lyon

Attorneys

April 28, 1942. D. R. DAVIS 2,281,272

FLUID FOIL

Filed May 9, 1938 2 Sheets-Sheet 1



INVENTOR.

David R. Davis

Look the same? They are.

The two patents by the same inventor were both for mathematical formulas for an airfoil. They were held by the courts to be substantially identical (even though both patents were issued). Double patenting was thus involved.

April 1, 1930. A. H. SCHMIDTKE 1,752,856

METHOD AND APPARATUS FOR MAKING BASKETS

Filed March 26, 1928 2 Sheets-Sheet 1

Fig. 1.

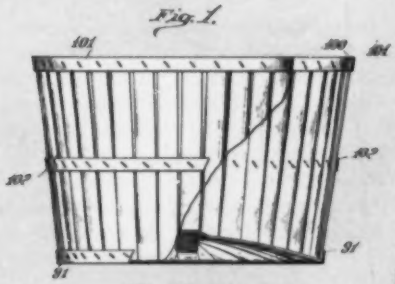
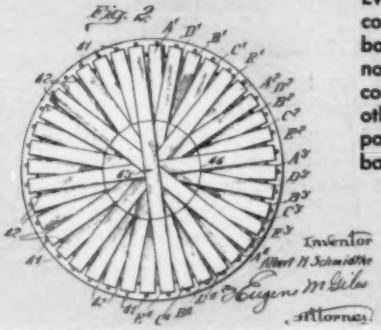


Fig. 2.



Inventor

Albert H. Schmidtke

By Eugene M. Geleo

Attorney

Jan. 31, 1933. A. H. SCHMIDTKE 1,895,586

BASKET

Original Filed March 25, 1928

Fig. 1.

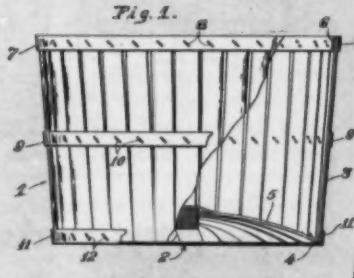


Fig. 3.

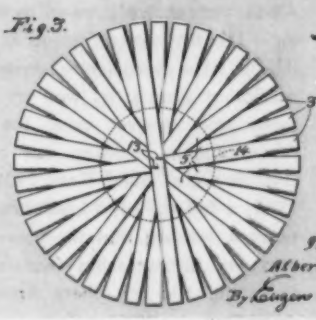


Fig. 2.



Inventor.

Albert H. Schmidtke

By Eugene M. Geleo Atty

Look the same? They're not.

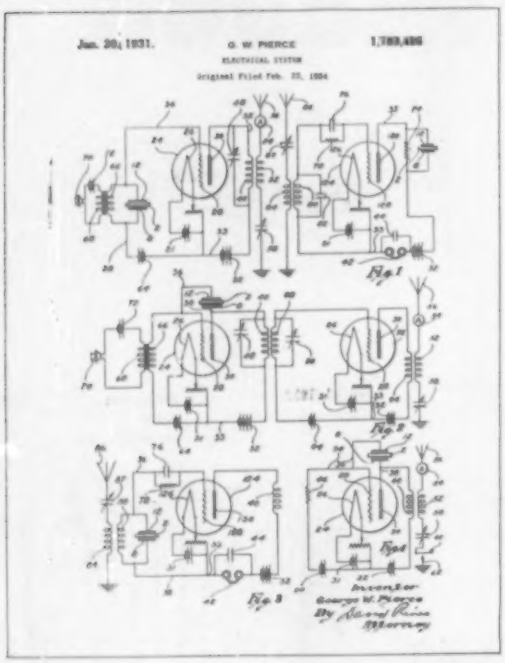
Even though both patents are concerned with the same basket, double patenting is not involved. One patent covers the basket itself; the other, a method and apparatus for making the basket.

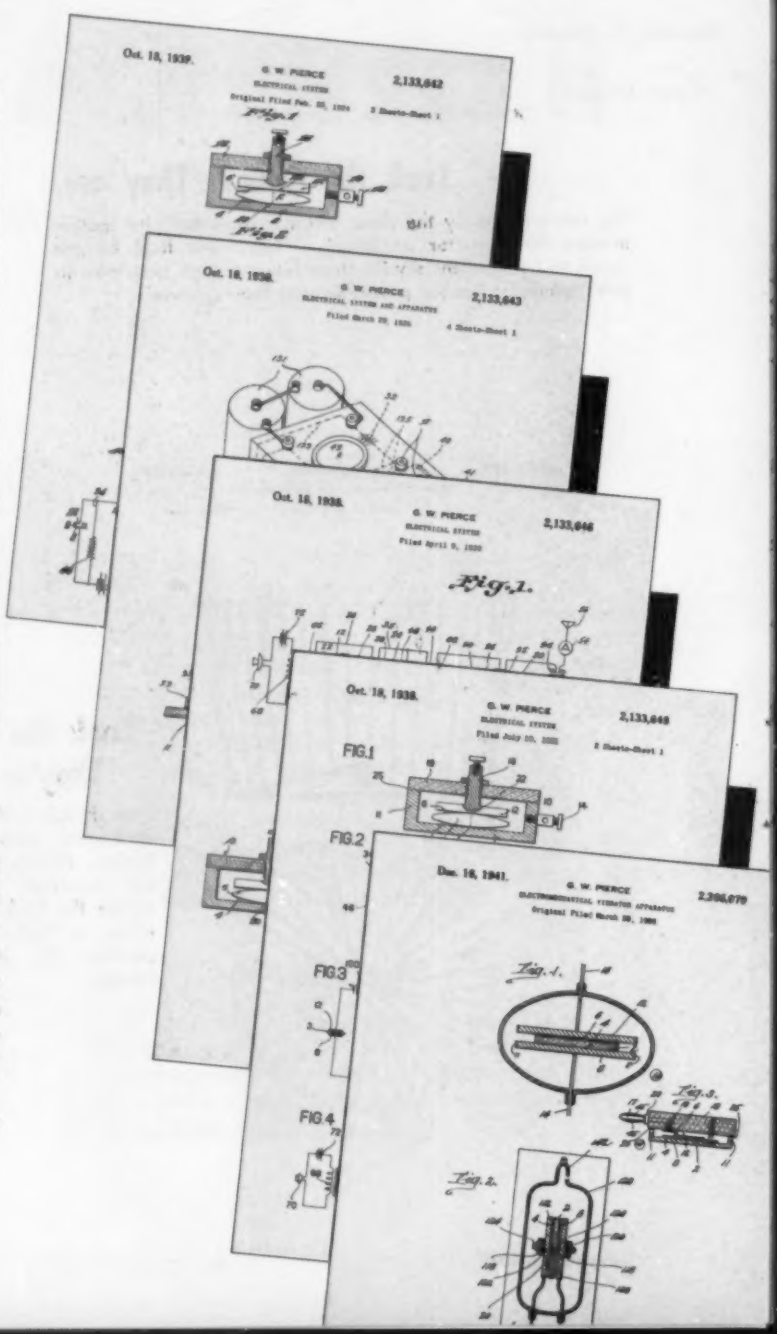
in another way, has not been made integral with another invention already patented so as to be fairly necessary to its use, it should be sustained."

But, "If the claims are so related that the separately claimed element constitutes the essentially distinguishing feature of the combination as claimed, different concepts are not involved, the inventions are not distinct and double patenting will be found."

As a specific example where separate patents might be upheld, ". . . a party might be entitled to a patent for a combination because of the cooperation of the elements contained therein and at the same time be entitled to a separate patent for one of the elements of the combination."[2]

Other exceptions were mentioned by the federal court in Massachusetts, in a case involving the same





One patent knocks out five

All six patents were issued to the same inventor. The first patent, issued in 1931, covered the use of a piezoelectric crystal to control an oscillating system, as well as a radio transmitter and receiver using the crystal. Five other patents involving use of piezoelectric crystals were issued from 1938 to 1941. In 1959, a federal court invalidated all five later patents, holding that the piezoelectric crystal was the distinguishing feature of the 1931 invention, and all others represented double patenting.

patentee. The court said, ". . . the charge of double patenting cannot be sustained where the first of two patents to be issued on co-pending applications is for an improvement upon the basic invention on which the later patent is issued, or where the first is for a narrow or specific form of what is claimed broadly or generically in the second or where one is of a specific combination which includes as one of its elements the subject matter of the second."[3]

Even though separate patents may be granted and finally upheld by the court, litigation may result if the claims of the first and the second patent are difficult to distinguish because of features common to both.

For instance, a patent application was filed by an employee of an Arkansas basket manufacturer entitled, "Basket and Method and Apparatus for Making Same." The inventor was required by the Patent Office to set out his application in two petitions, one for the basket itself and the other for the "method and apparatus," or machine claims. Patent was issued for the method and apparatus four years later, and on the basket itself, seven years later. Both of these patents were assigned by the inventor to his employer.

Later, when the manufacturer sued an alleged infringer of the second or basket patent, the infringer's defense was that there had been double patenting, and that the basket patent had been anticipated by the "method and apparatus" patent, issued three years earlier.

But the federal district court disagreed. It said, "The machine patent described the method and apparatus for making a basket and the basket patent described the construction of a basket. The claims of the machine patent are not co-extensive with the claims of the basket patent and do not teach or disclose all that is found in the latter patent. In other words the basket patent represents a distinct, different and separable invention from that of the prior machine patent."[4]

This decision was appealed to the United States Court of Appeals. There, one distinction was made that may save an inventor from a charge of double patenting and the consequent loss of his patent monopoly, ". . . it is well settled where the second patent covers matter described in the prior patent, essentially distinct and separable from the invention covered thereby and claims made thereunder, its validity may be sustained.

"As an example it is not double patenting when an inventor makes a new improvement on his own invention of a patentable character, for which he may obtain a separate patent. Where the invention is distinctly different and independent from that covered by the first patent the later patent may be validly granted.

"In the present case the Patent Office required divisional applications for the machine and basket patents. The claim of the machine patent covered a machine for making a basket. The claims in the basket patent covered a basket."[5]

Double Patenting—or Double Inventors?

It is not double patenting when two patents are issued for the same invention to two different inventors.

In one case, patents had been issued to separate inventors and both subsequently assigned to one company. The assignee sued a Delaware corporation for infringement, and the defense claimed that double patenting was involved. The federal court held that double patenting was not involved. It said, "Where two patents for the same invention are issued to different inventors, . . . the validity of one patent as against the other will presumably rest primarily upon the question of priority of invention.

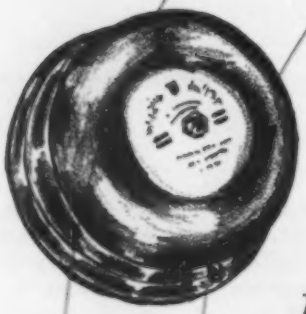
"Where the two patents are issued to the same inventor there can properly be no question of priority of invention and the second patent is by the very nature of the case, void, as there might otherwise be a possibility of an inventor extending his monopoly for a term of more than seventeen years to which he may be entitled.

"The assignment makes no difference, each patent standing precisely as if there had been none such. The earlier invention should and will prevail if the inventions are the same. If they are different both ought to stand.

"The only reason whatever for the defense of double patenting is that since the inventor is the same in each the defense could not succeed that the inventor of the second was not the first inventor."[6]

REFERENCES

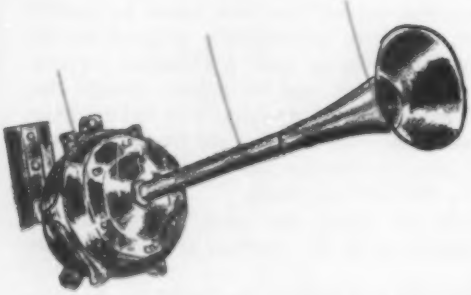
1. Davis Airfoils Inc. v. United States, 124 *F.S.* 350, October 5, 1954.
2. Pierce v. Allen B. Du Mont Laboratories Inc., 178 *F.S.* 84, Del., Sept. 15, 1959.
3. Pierce v. American Communications Co., 111 *F.S.* 181, Mass., Mar. 19, 1953.
4. Hope Basket Co. v. Product Advancement Corp., 89 *F.S.* 116, Mich., Feb. 17, 1950.
5. Hope Basket Co. v. Product Advancement Corp., 187 *Fed.* 2d 1008, Mich., March 29, 1951.
6. Federal Telephone & Radio Corp. v. Assoc. Tel. & Tel. Co., 99 *F.S.* 535, Del., June 26, 1951.



How to specify
AUDIBLE

EDWIN A. HARRIS and **WALTER E. LEVINE**
OEM Product Development Manager — Senior Project Engineer, Audible Signals

Edwards Co.
Norwalk, Conn.



MATCHING sounds—or signal devices—to applications need not be a trial-and-error procedure. If the fundamentals of sound are applied to such variables as ambient conditions, characteristics of common sound-producing devices, and, above all, purpose of the signal, selection of equipment is simplified. This article presents a summary of the properties of sound and relates them to the selection of devices that produce sound.

● Sound

In an analysis of sound, three basic, interrelated characteristics must be considered: 1. Pitch. 2. Loudness. 3. Quality.

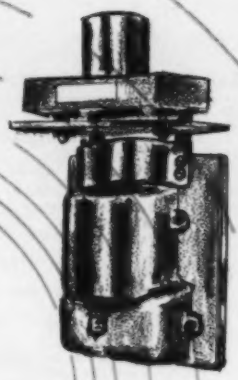
Some sounds, like those produced by musical instruments, voice, and many signaling devices, have a property the ear recognizes as pitch. Others, like the blow of an axe on wood or the report of a gunshot, are without pitch. Pitch is determined by the frequency of vibration which produces the sound. If a sound has no clearly defined or predominant frequency—hence no pitch—it is no longer musical and is called noise.

A sound with a definite pitch is called a tone. Tones, or musical sounds, can differ from one another in loudness and quality. A pure tone, such as that produced by a tuning fork, is always represented by a simple harmonic curve or sine wave.

When a tuning fork is set into vibration in air or water, its sound gradually weakens in intensity as energy is transferred into the surrounding medium; however, the pitch of the sound remains the same throughout its duration.

The pitch of a sound is the same whether the sound is loud or soft, regardless of how it is produced. Also, pitch rises as frequency is increased. Although all curves representing fundamental tones are sine waves, the wave lengths differ, varying inversely as the frequency in a given medium.

Complex Tones: The sound produced by a signaling device may have any degree of complexity—depending on the number of pure tone constituents



SIGNALS





—and have any form of wave shape. Complex sounds, however, can always be reduced to their simple harmonic components for analysis.

When structures vibrate in more than one way, complex sounds are produced as a result of the superimposed vibrations. For example, if one of the tangs of a tuning fork is struck while the fork is vibrating, a "ping" or metallic click will be heard for a short time. This click, called the "clang tone," is usually 2½ octaves above the normal tone of the fork.

Generally, a complex wave form is of higher frequency than the pure tone or natural frequency of an object or structure. The curve of such a wave form is a resultant of the crests and troughs of each simple harmonic wave as they reinforce or dampen one another, Fig. 1.

Sensitivity of the Human Ear: The energy of a vibration is proportional to the square of the amplitude of the sound wave. For a tone of given pitch and quality, intensity depends on the rate of trans-

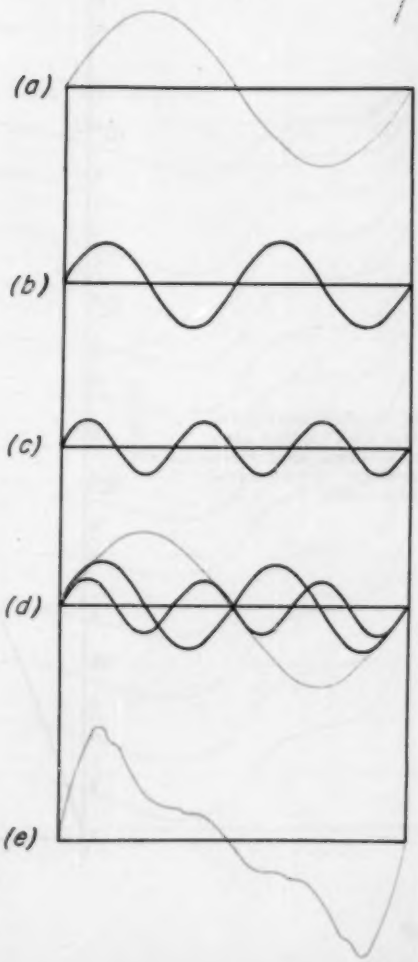


Fig. 1—Wave-shape synthesis of a complex tone: *a*, basic tone or fundamental frequency of sound-producing unit; *b*, first impressed overtone (clang tone); *c*, second impressed overtone (many more overtones can exist); *d*, superimposed tones; *e*, resultant tone heard by listener.

mission of this energy from the source to the ear. Sound waves carry the energy of vibration through a plane at right angles to the direction of transmission. The intensity of the wave motion is the number of ergs of energy carried in one second through a square centimeter of the plane.

This unit has no special name. However, 1 erg per sec is a measure of power, and 10^7 ergs per sec equal 1 w. The intensity unit, therefore, equals 10^{-7} w per sq cm. The extreme sensitivity of the ear as a detector of sound energy justifies the use of such a small energy unit.

The smallest amount of energy that an ear can detect (the threshold of hearing) depends mainly on the pitch of the sound. The ear responds to a very small variation of pressure—about 1 dyne per sq cm—when the tone has a pitch somewhere between 25 and 20,000 cps.

Conversely, the ear has its threshold of pain. As more and more sound energy reaches the ear, vibrations set up in the ear-drums and inner ear can cause pain and, possibly, injury. Again, the

Table 1—Typical Levels of Sound Intensity

Intensity (db)	Description or Effect	Source
180	Impairs hearing	Rocket engines
160	Impairs hearing	Jet aircraft engines
140	Pain	Jet aircraft engine
120	Threshold of pain	Thunder, artillery
110	Deafening	Nearby riveter, elevated train
100		Boiler factory, loud street noise
90	Very loud	Noisy factory, unmuffled truck
80		Police whistle, noisy office
70	Loud	Average street noise, average radio
60		Average factory, noisy home
50	Moderate	Average conversation, average office
40		Quiet radio, quiet home or private office
30	Faint	Average auditorium, quiet conversation
20		Rustle of leaves, whisper
10	Very faint	Soundproof room
0		Threshold of hearing

From *Mark's Mechanical Engineers' Handbook*, Sixth Edition, McGraw-Hill Book Co. Inc., New York, 1958, Section 12, p. 153.

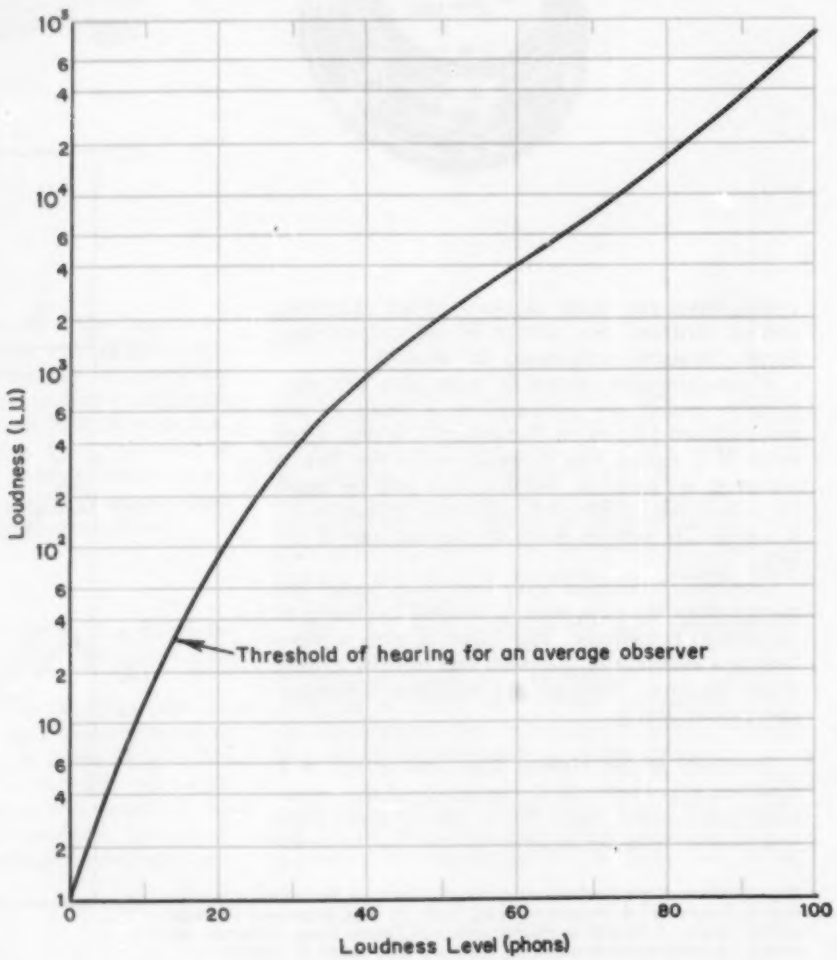


Fig. 2—Relationship between ASA loudness units and loudness level. From American Standard Z24.2—1942.

amount of energy the ear can comfortably endure depends primarily on the pitch of the sound.

Thus, how we hear sounds depends on the intensity and the frequency of the sound wave and, to a lesser degree, on the wave form. The sensitivity of the average ear is greatest at frequencies between 1000 and 2000 cps.

Measurement of Sound: An absolute scale of sound intensity using ergs per sec per sq cm, or w per sq cm, would involve numbers too small for practical work. Therefore, a decibel scale is used based on the relative intensities of a reference sound and the sound to be measured. Throughout a moderate range of intensities, this relationship is expressed as $N = 10 \log I/I_0$, where N = intensity level of a given sound, db: I = intensity of the given sound, w per sq cm; I_0 = reference intensity, w per sq cm. (Or, intensities I and I_0 can be in ergs per sec per sq cm.) For comparisons, a practical zero for the intensity-level scale is $I_0 = 10^{-16}$ w per sq cm at 1000 cps.

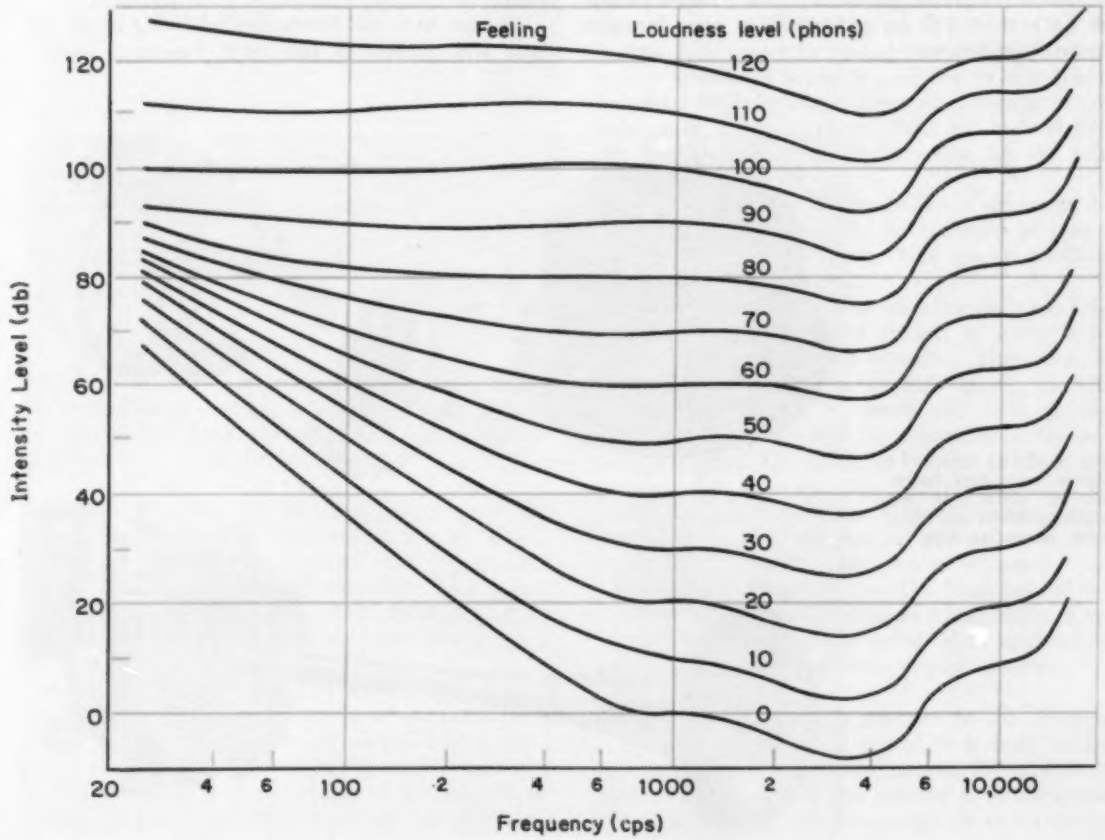
Approximate values of intensity levels for familiar sounds are given in Table 1. Because a change in level of 1 db is approximately the smallest that an average ear can detect, fractions of a decibel are seldom necessary.

Although the decibel scale of intensity levels is useful for comparing two sounds of the same pitch, a separate scale for loudness level is required for comparing two sounds of different pitches. Since loudness is sensation of feeling and is subjective, it cannot be directly measured. Therefore, scales of loudness in ASA loudness units (L.U.) or of loudness level in phons for comparing loudness are wholly arbitrary, Fig. 2. Zero point on these scales is the loudness, as heard by an "average" normal ear, of a sound wave in air. At the zero point the reference sound must have a frequency of 1000 cps and a pressure of 0.0002 dyne per sq cm at the ear of the listener. (American Standard Z24.2—1942.)

When sounds of 1000 cps are compared, loudness level in phons is numerically equal to the intensity level in decibels. However, at nearly all other frequencies, loudness level and intensity level have different numerical values, Fig. 3.

To compare a sound of different pitch (frequency) with the reference 1000-cps sound, the intensity level of the reference sound is raised until the two sounds are, or seem to be, equally loud. Then the number of decibels in the intensity level of the reference sound is used to calculate the loudness level in phons of the second. An increase of approximately

Fig. 3—Relationship between intensity level and loudness level for various frequencies. From American Standard Z24.2—1942.



3 db represents a doubling of the loudness level as heard by a listener. Values are compared in Table 2.

• Selection Factors

The first step in the selection of an audible signal is an evaluation of its function:

- Is the signal to be a warning, a call, or an instruction?
- Will the signal indicate an emergency or a routine condition?
- How much time will be available to take action?
- Will the signal sound at regular intervals or infrequently?
- Must it function near other signals with which it might be confused?
- What is the ambient noise level?
- Will the signal be protecting life or valuable equipment?

Another factor is the degree of irritation desired in a signal. For instance, a deliberately distorted tone is desirable to warn an airplane pilot of unlowered landing gear. This signal, normally produced by a horn, is made piercing by increasing its decibel level and frequency spectrum (usually to the 3000-4000-cps range) to distinguish it clearly from ambient noise. On a bus, however, a signal to the driver should not irritate the passengers, yet must be distinctive enough to attract the driver's attention. Here the sound is made "sour" (sharp or flat) so it will be recognized at once but not be overly irritating.

The proper signal frequency must also be determined. Occasionally a question arises over whether to specify the frequency generated by the "motor" unit or the audible frequency produced by the signal and transmitted to the ear. Because the sound to be heard by the user is the audible frequency of a signal, this frequency should normally be indicated in specifications. Once the audible frequency has been determined, selection of the operating frequency is relatively simple.

• Types of Devices

The audible signals most widely used are buzzers, bells, horns, chimes, and sirens.

Buzzers: The sound of a buzzer is produced by a sympathetic-vibrating reed. Tone and quality of the sound depend largely upon length of reed and frequency of vibration. For ac operation the buzzer is tuned to the line frequency, and tonal differences are obtained by varying the type and shape of reed.

Dc buzzers are equipped with interrupting contacts (optional on ac units). One contact point is attached to the vibrating reed. The other is adjustable in relation to the vibrating reed. Changing the stroke of the reed also changes its resonant point so that the tone of the buzzer can be varied over a wide range.

Buzzers have the lowest decibel rating of all signals and operate in the lower frequency levels—

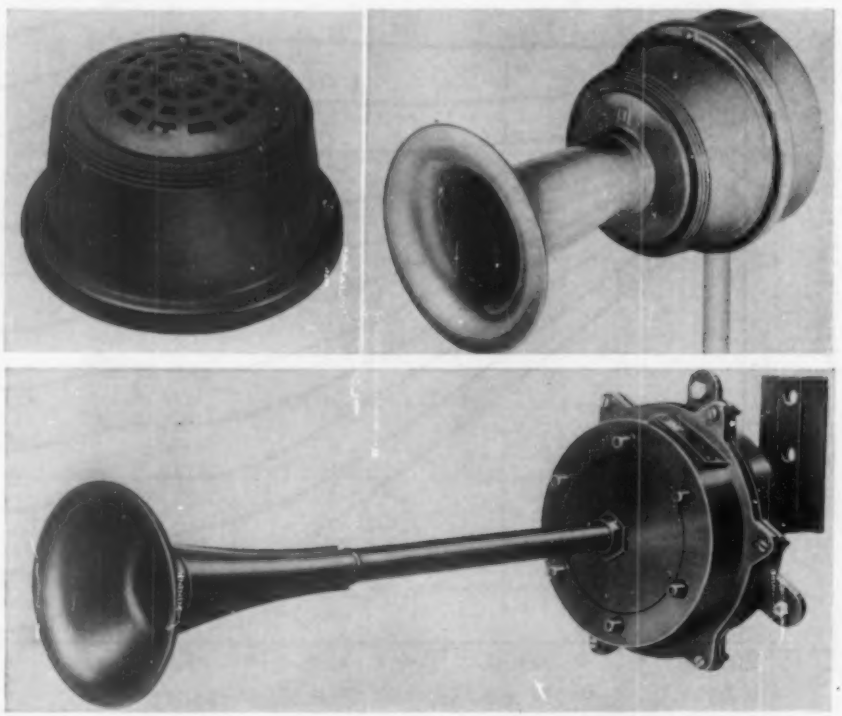


Fig. 4—Electrically driven heavy-duty horns: top left, grille type; top right, projector type; bottom, resonating type.

approximately 150-400 cps. However, special designs operate at frequencies from 20-1500 cps. These are usually specified for quiet locations where their distinctive sound commands attention yet does not cause alarm.

Bells: Electrically driven bells are classified as either single-stroke or vibrating types. Both types are available in ac or dc versions. Further, ac vibrating bells are operated either by clappers or plungers (solenoids). Plunger models can be biased with permanent magnets, rectifying units, or differential springs. Vibrating bells for dc operation also use clappers and plungers.

Bells normally have higher intensity-level and frequency ratings than buzzers and can be obtained in a wide range of both ratings, depending on size. In general, the larger the gong, the higher the intensity and the lower the frequency.

Table 2—Comparison of Intensity Level and Loudness

Intensity Level (dB)	Loudness (L.U.)*
40	975
45	1,500
65	5,870
75	11,400
83	25,000
90	57,000
95	75,000
100	88,000
105	138,000
108	150,000
106	180,000
110	215,000
112	260,000
114	316,000
115	346,000
117	418,000
120	556,000
122	668,000
123	732,000
140	4,000,000
155	10,000,000
160	17,000,000

*ASA loudness units.
Also see conversion charts, Fig. 2 and 3.

When a bell gong is struck and the percussion sets up a resonance in the gong, many tones are generated. Ideally, for the gong to sound "clean" and provide the distinctive sound of a bell, it must vibrate at its own natural frequency. This condition is called "breathing." A beat frequency of 60 cps has been found to give optimum sound for a particular gong configuration.

Bell tones can be varied by modifying the gong configuration as is done with a "cow" gong or slotted gong. The cow gong, which is shaped like a truncated pyramid, has four nodes or dead areas—one at each intersection of the planes of the bell. When a cow gong is struck, the resulting tone is dulled because of the deliberate sacrifice of resonance. Thus, the tone of a cow gong is easily distinguishable from the tones of conventional bell gongs.

Slotted gongs, which usually have two or four slots cut radially in the gong rim, have dead areas at the slots. Here, too, resonance is deliberately reduced, but not to the same degree as in cow gongs. Slotted, or muted, gongs produce a brilliance of sound somewhere between that of full gongs and cow gongs. These types are specified for applications where a distinctive tone is required.

Plunger Type, Ac: To take advantage of the phenomenon whereby the best sound is produced at 60 cps, plunger-type bells are designed to use only half the pulsations available from standard line frequency—60 peaks per sec instead of 120.

For differential-spring bells, a pair of springs slows the plunger action to approximately 60 strokes per sec. Because springs change in mode as a result of vibratory exertion and inertia, this type of bell does not hold a constant vibrating frequency, hence does not sound "clean."

For rectified-type bells, a half-wave rectifier reduces the line frequency to 60 pulses per sec. The major objection to this type of bell is the large amount of input power required to produce an audible signal.

For permanent-magnet bells, a permanent magnet reduces the effect of the negative portions of the current wave. Additional power is generated on the positive half cycles by spring compression. Thus, a greater amount of sound is produced by this type of bell than by bells which operate on normal or unemphasized current pulses. Also, this method does not sacrifice any of the input power for the extra sound output.

Clapper Type, Ac: These bells are similar in design to buzzers except that an armature or reed is extended to contact a gong. This type is available for either ac or dc operation.

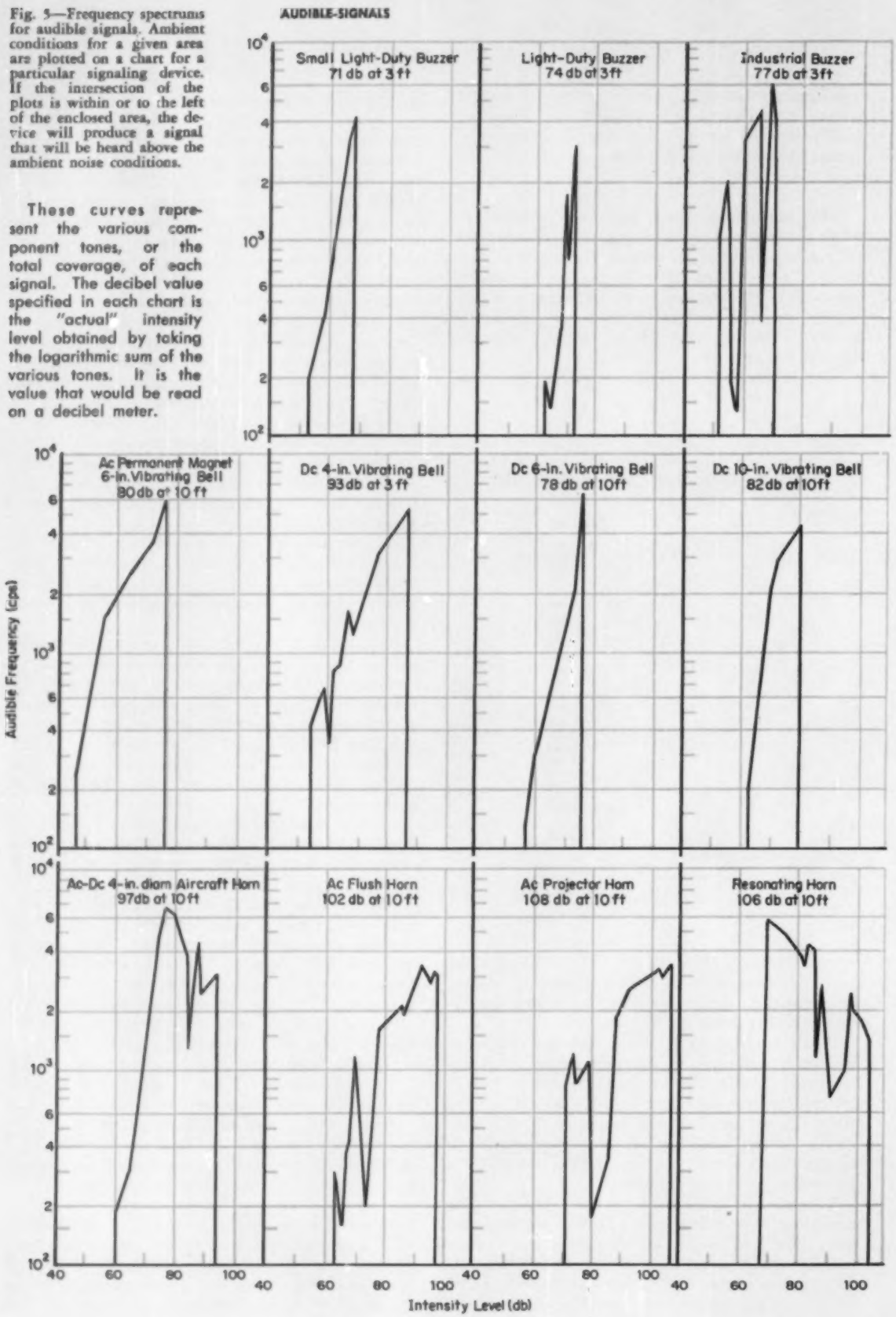
Plunger Type, Dc: These vibrating bells use solenoid mechanisms attached to sets of contacts for opening and closing the circuits. They can be equipped with capacitors to limit arcing, or with snap-action switches to break the arcs quickly. Principal advantages are the controlled stroke and vibratory speed. Dc units can vibrate at lower frequencies than ac units and thus produce high intensity levels at fairly low apparent-power inputs. Units with contacts can also be operated on ac power, although with some sacrifice in efficiency.

Single-Stroke Type, Ac and Dc: Most bells of this type use the plunger or solenoid construction. They are primarily designed for coded-signal applications such as fire-alarm or audible-paging systems.

Horns: A horn sound is produced by the vibration of a diaphragm which is pulsed with high impact by magnetic or mechanical means. In ac and dc types of horns, Fig. 4, this pulsing is accomplished by means of either electromagnets or motor-driven

Fig. 5—Frequency spectrums for audible signals. Ambient conditions for a given area are plotted on a chart for a particular signaling device. If the intersection of the plots is within or to the left of the enclosed area, the device will produce a signal that will be heard above the ambient noise conditions.

These curves represent the various component tones, or the total coverage, of each signal. The decibel value specified in each chart is the "actual" intensity level obtained by taking the logarithmic sum of the various tones. It is the value that would be read on a decibel meter.



cams. In mechanical types of horns, the diaphragm is actuated by a hammer or a pulsating jet of air or gas.

Tubes or resonators are often added to horn drivers to amplify and direct the sound. The column of air in a properly proportioned projector is vibrated at the horn frequency. These resonators give the horn a distinctive, penetrating sound.

Horns do not fall into any fixed category as to decibel rating and frequency. In general, horns are available as "growlers" with low frequencies and relatively high intensity levels (90-100 db), and as "screamers" with very high frequencies (3000-5000 cps) and high intensity levels.

Chimes: Available in ac (primarily) or dc versions,

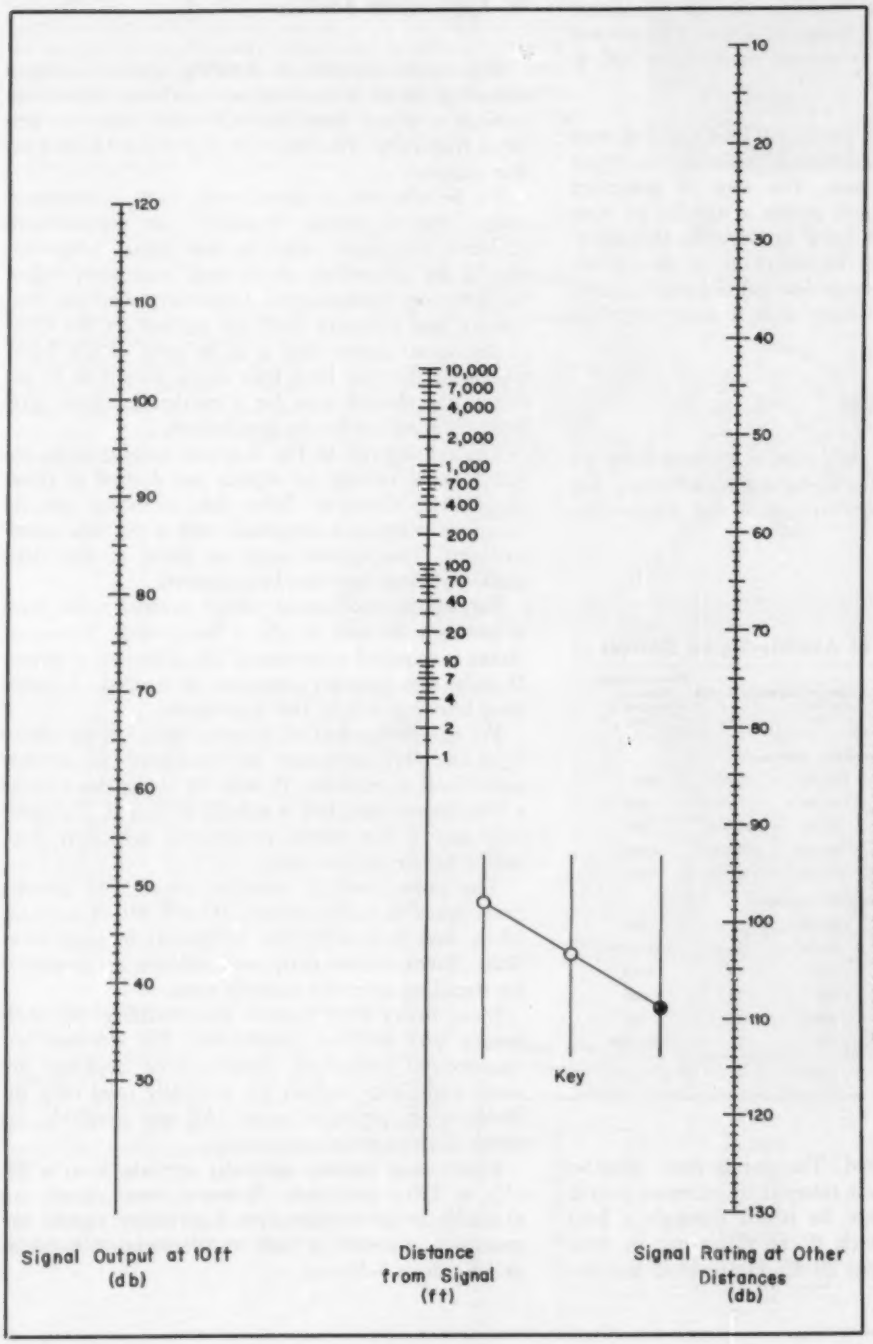


Fig. 6—Nomograph for change in signal strength with distance. Values are based on tests performed in an anechoic chamber in clear, still air with no obstructions or reflections. To illustrate application of the nomograph, find the decibel rating at 40 ft for a horn with an intensity level of 98 db at 10 ft. A line from 98 db on the left scale is drawn through 40 ft on the center scale. Extending the line to the right scale gives a value of 86 db.

chimes, like bells, provide a choice between single-stroke or vibratory action. A chime is primarily a solenoid device which strikes a tuned bar or gong. Chime tones can be varied by using bars of different length, thickness, cubic volume, or shape to produce distinctive musical tones. Or, different bar materials may be used—brittle steel, aluminum, brass, bronze—depending on the tone desired. Each material has its own characteristic brilliance of sound.

To mellow the tone of a bar chime and make it louder, a resonating container of air is frequently added. The resonating chamber can be cylindrical or cubical or have any irregular shape. The normal frequency spectrums for chimes range from 500 to 1000 cps.

Sirens: These devices produce a loud piercing tone with an intensity level which approaches the upper limit of human tolerance. The tone is generated by a vane or disc which passes a number of slots to let air escape at a fixed or variable frequency. Sirens can be powered by either ac or dc motors.

Sirens are not adaptable for coded signals. However, the rising and falling wail is most useful as an emergency warning.

• Ambient Conditions

Loudness, frequency, and type of ambient noise are the major criteria influencing signal selection, but the sensitivity and peculiarities of the human ear must also be considered. The ear is most sensitive to faint sound and least tolerant to excessive sound. A faint sound will not be heard through a loud sound of the same pitch if the difference in their intensities exceeds about 20 db. However, if the two sounds are of very different pitch, even though the two intensities differ greatly, the faint sound will be heard.

Generally, a low-frequency ambient condition with a high intensity level requires a high-frequency signal with a high intensity level for best results. Audible signals can be rated in decibels, phons, or ASA loudness units, but the decibel system of rating is used in Table 3.

Table 3—Ratings of Audible-Signal Devices

Type	Average Intensity Level At 10 ft (db)	At 3 ft (db)	Predominant Audible Frequency (cps)
For large areas (high-intensity coverage)			
4-in. bell	65–77	75–83	1000
6-in. bell	74–83	84–94	600
10-in. bell	83–90	95–100	300
Horn	90–100	100–110	5000
Siren	100–110	110–121	7000
For small areas (low-intensity coverage)			
Heavy-duty buzzer	50–60	70	200
Light-duty buzzer	60–70	70–80	400–1000
1-in. bell	60	70	1100
2-in. bell	62	72	1000
3-in. bell	63	73	650
Chime	69	73	500–1000

• Application Factors

The main objective in locating and selecting a signaling device is to overcome ambient sound and provide a signal frequency different from the ambient frequency. The charts in Fig. 5 can be used for this purpose.

To be effective, a signal must have a frequency range, Fig. 5, which "brackets" the predominant ambient frequency; that is, the signal frequency should be somewhat above and somewhat below the ambient fundamental frequency. Ambient frequency and intensity level are plotted on the chart of the signal device that is to be used. If the intersection of the two lines falls either within or to the left of the shaded area for a particular signal, that device is adequate for the application.

The nomograph in Fig. 6 is also helpful when intensity-level ratings for signals are desired at other than 10-ft distances. Note that a rating has no meaning unless it is combined with a distance measurement. Two signals must be rated at the same distance before they can be compared.

For equipment located where normal noise level is between 50 and 60 db, a heavy-duty buzzer or chime is required to command the attention of many. If only one person's attention is needed, a light-duty buzzer or a 1-in. bell is adequate.

For equipment located in open factory areas where light assembly operations are conducted, the normal noise level is between 70 and 80 db. In such areas a 6-in. heavy-duty bell is usually sufficient. To signal only one or two people, however, a light-duty 3-in. bell or buzzer can be used.

The noise level in machine shops and punch-press areas is approximately 90-100 db. A horn or 10-in. bell is required for equipment in such locations. Sirens, infrequently used indoors, are preferred for signaling over vast outdoor areas.

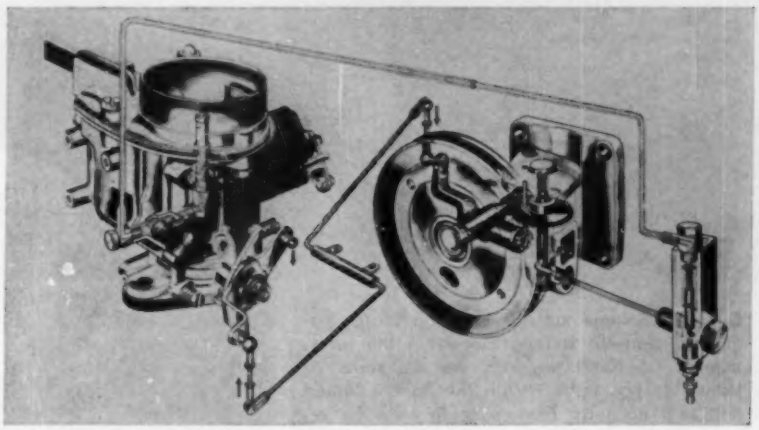
Most heavy-duty signals are available for both indoor and outdoor installation. For extreme environmental conditions, weatherproof housings are used. Light-duty signals are normally used only indoors or in protected areas. All are available for either flush or surface mounting.

Heavy-duty signals generally operate from a 24, 115, or 230-v ac supply. However, most signals are available in dc counterparts. Light-duty signals are generally powered by bell transformers or batteries at 3-6 v dc or 8-10 v ac.

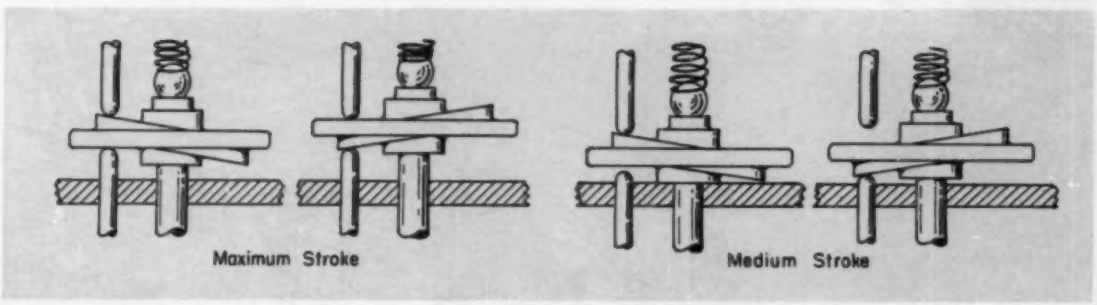
Oil Injector Eliminates Messy Mixing For Two-Cycle Engine

CONVENTIONAL two-cycle engines use a previously prepared mixture of fuel and oil. Once in the tank it cannot be varied to meet power demands. A new oil injection system, used in DKW's two-cycle auto engine, automatically meters oil into the engine as it is needed—more during high demand periods, less during idling. Resulting exhaust is as clean as that from four-cycle engines, says the manufacturer.



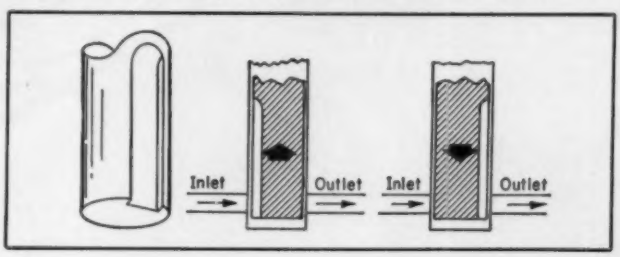


Throttle lever operates linkage to turn control cam. Rise and fall of control pin determines amplitude of pump stroke. Pulley wheel operates on engine fan belt and drives pump gear through a worm.



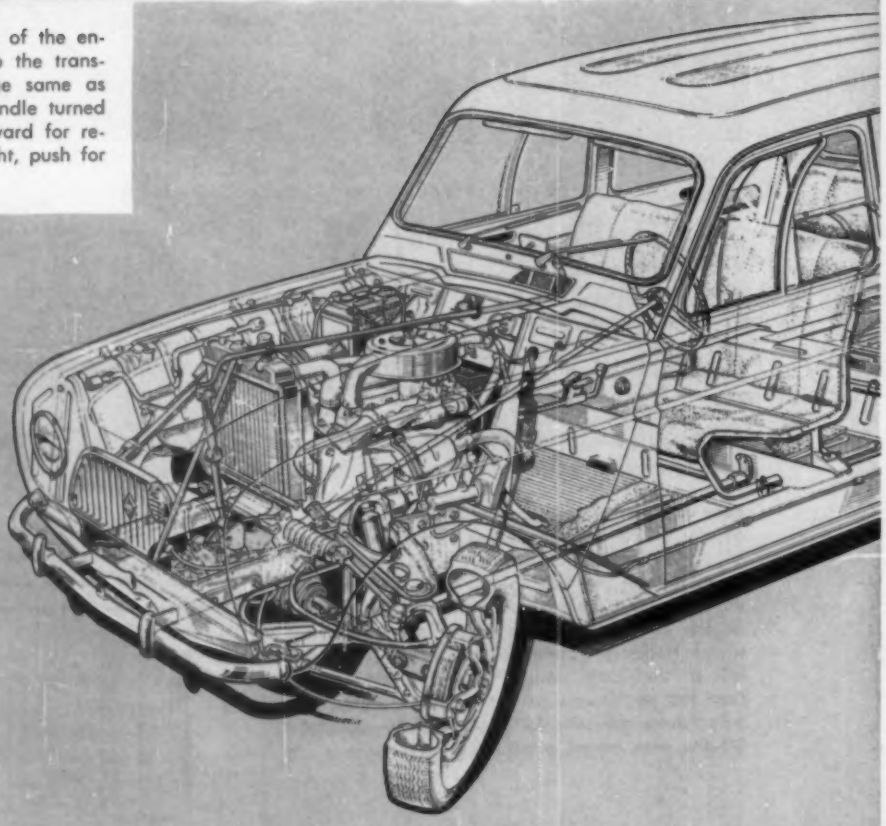
Face cam on the gear oscillates gear and shaft axially as the cam passes over the control pin. Spring over the shaft restores it to the lower position after the crest of the cam has passed the pin. In high-flow position, the cam rides on the pin for the whole circuit, so the stroke transmitted to the pump is equal to the rise and fall of the cam. In partially throttled position, the pin lowers, and the cam bears on it only where the cam surface is high enough to lift the gear wheel off its bearing base.

Rotating gear shaft doubles as valve and piston. Tapered keyway faces inlet on up stroke, outlet on down stroke.



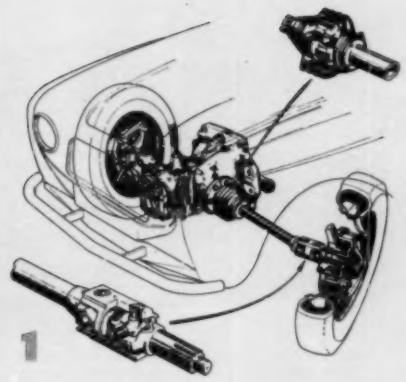


Gearshift linkage extends over top of the engine to transmit shifting motion to the transmission. Shifting positions are the same as standard stick shifts: With the handle turned left, pull back for low—push forward for reverse. With the handle turned right, push for second—pull for high.



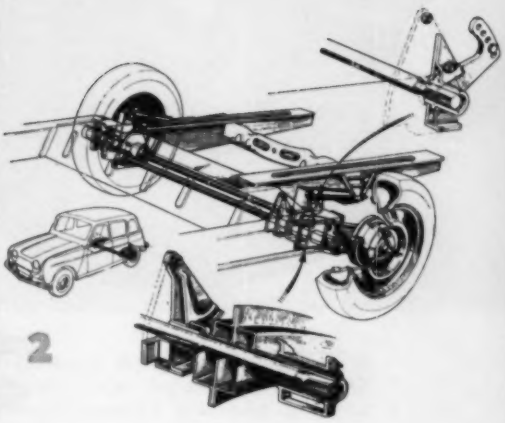
Stick Shifts Up-Front Transmission

RENAULT's entirely new car layout posed several design problems which their engineers solved quite neatly: Manual shift for up-front transmission, constant-velocity joints for front-wheel drive, expansion tank for sealed cooling system, and rear shock absorber system that does not protrude into the luggage deck.



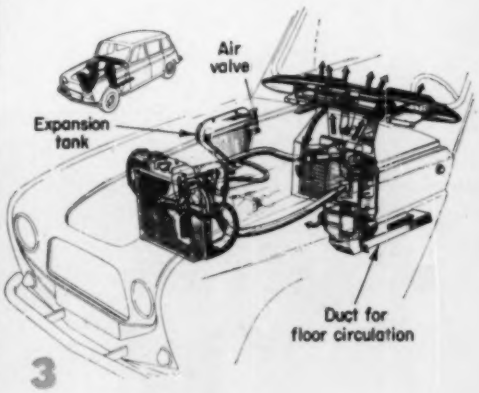
1

Constant-velocity joints between transmission and wheels include Bendix-Weiss ball-and-groove types next to the transmission housing, and double universal joints near the wheels. The two sets allow the drive shaft to compensate for up-and-down wheel motion.



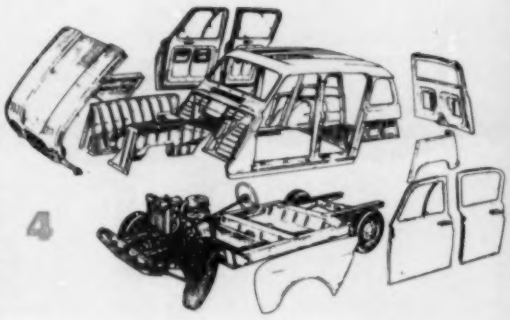
2

Rear wheels are mounted on trailing arms that rotate on torsion bars. Vertical horns on the arms are coupled to horizontal shock absorbers—leaving the luggage deck clear of protrusions. To allow the full-car-width torsion bars to operate in the same horizontal plane with identical linkage right and left, one rear wheel is positioned slightly behind the other. This makes the left wheel base 1.9 in. longer than the right.



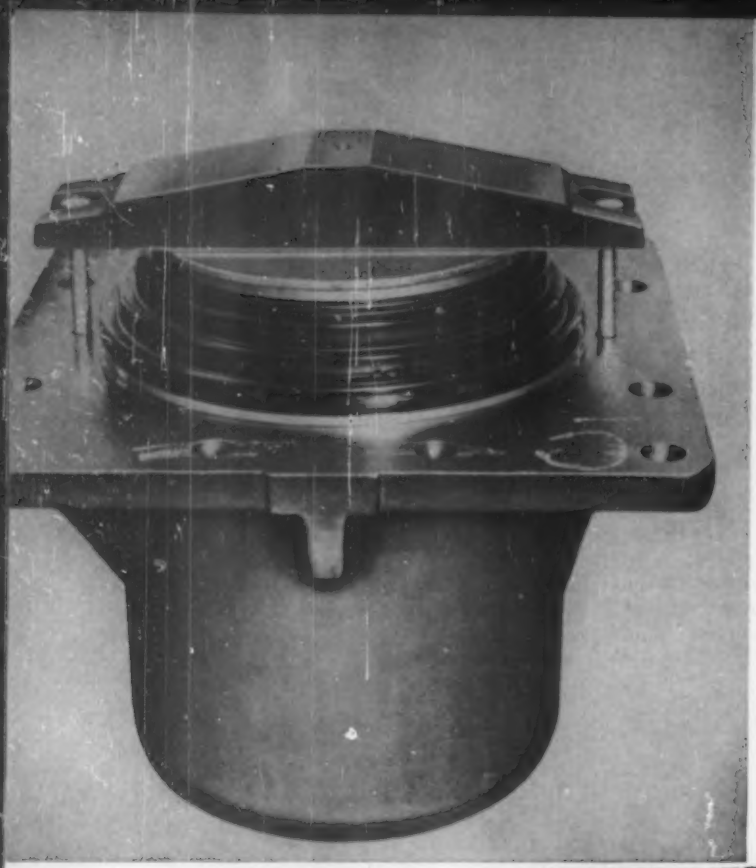
3

Sealed cooling system vents into a side-mounted expansion tank. Air relief valve admits or releases air when design pressure limits are reached. Level of glycol mixture used as coolant remains above the capillary entrance to the expansion tank. In deluxe version, car heater has fan to boost circulation during stops.

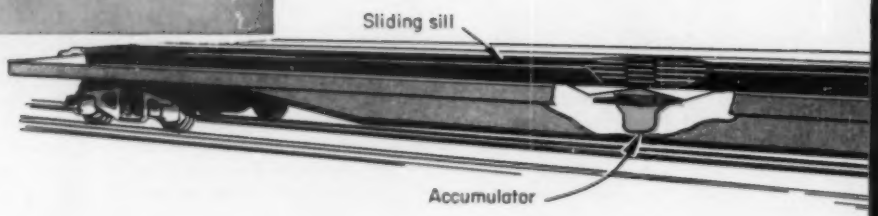


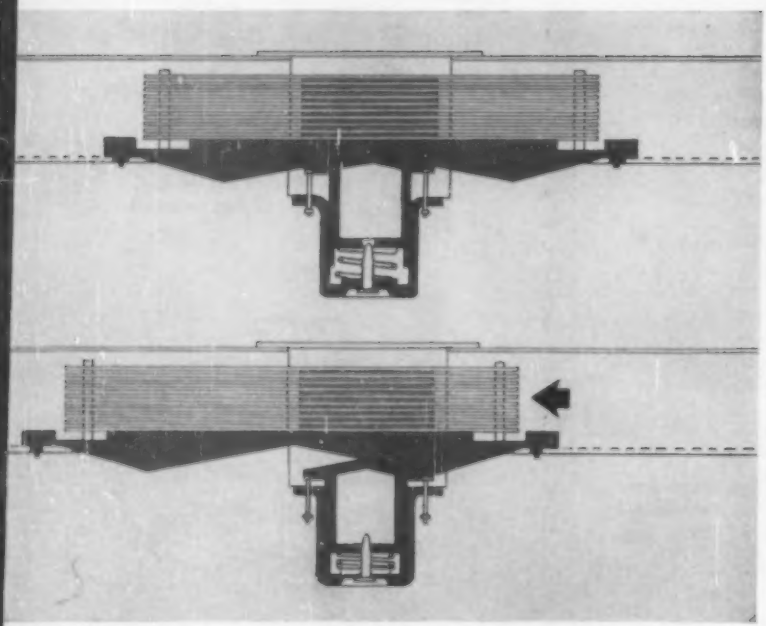
4

Bolt-on panels make repairs cheap and easy, says Renault. Front-wheel drive effectively eliminates drive-shaft tunnel. Spare tire is stored under luggage deck.



SHOCKS that freight cars are called upon to absorb often damage fragile cargoes if they are not properly cushioned. A new shock-absorbing system allows a car to be coupled at speeds up to 13 mph without damage to its contents. The snubber is one of the features of a new triple-deck auto transport developed by Evans Products Co., Plymouth, Mich.

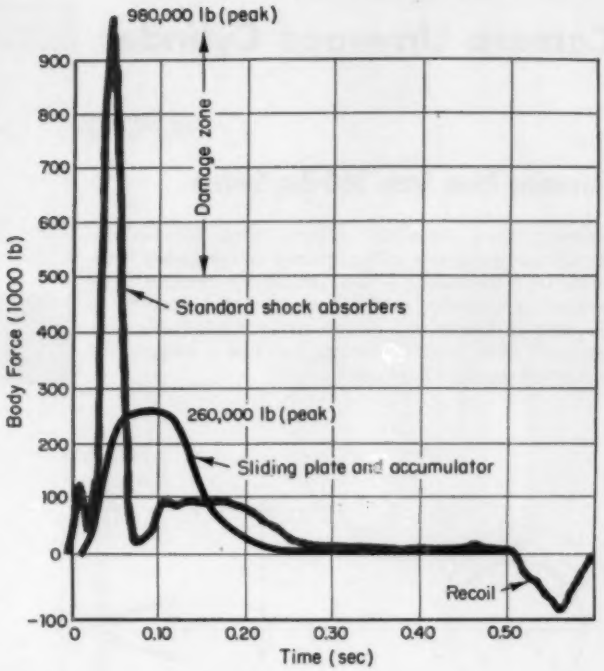




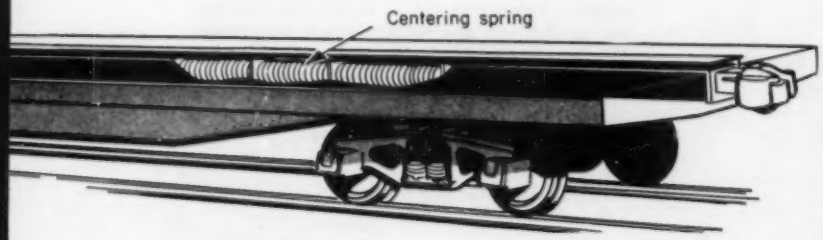
Stacked plates slide over each other absorbing energy. Cam-like undersurface of the sliding sill compresses the accumulator and puts more and more pressure on plate faces.

Shock absorbing unit, called Hydra-Cushion, was developed by Southern Pacific Railroad and Stanford Research Institute. It's being produced by Hydra-Cushion Inc., owned by Evans Products Co., and Waugh Equipment Co. The auto transport is built by Thrall Car Mfg. Co., Chicago Heights, Ill.

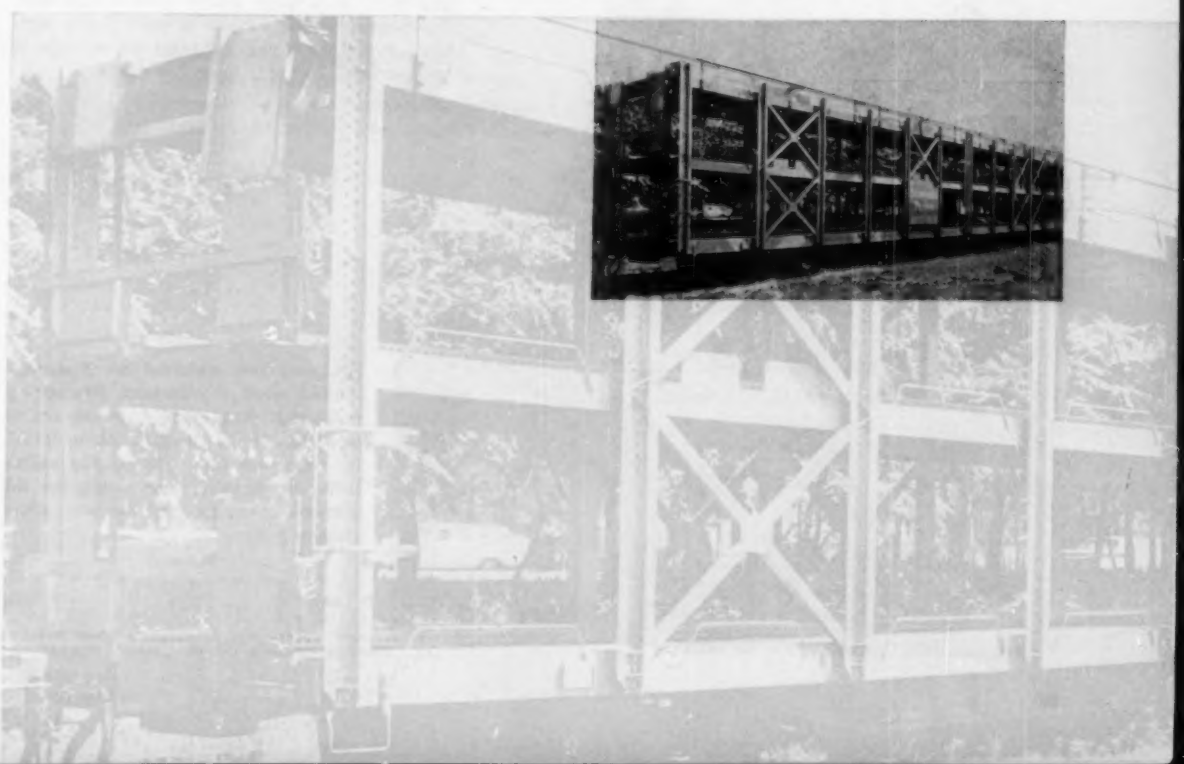
Sliding Plates Snub Auto-Carrier



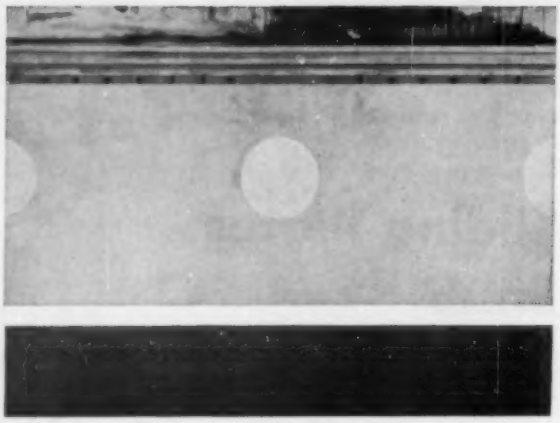
Shock profile for 9-mph impact shows new shock absorber distributes energy of peak load keeping it well below the danger zone. No recoil force is shown for the new unit. Designers say at least 11 per cent of all shocks in switching yards occur at speeds of 9 mph or more.



Centering spring restores the sill to normal after the shock is past. All shock-absorbing equipment is below deck level, leaving the entire upper surface free for cargo.

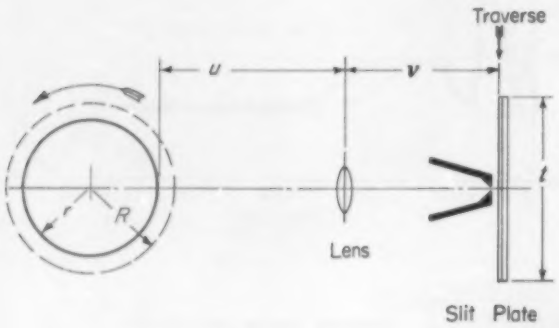


Camera Unwraps Cylinder

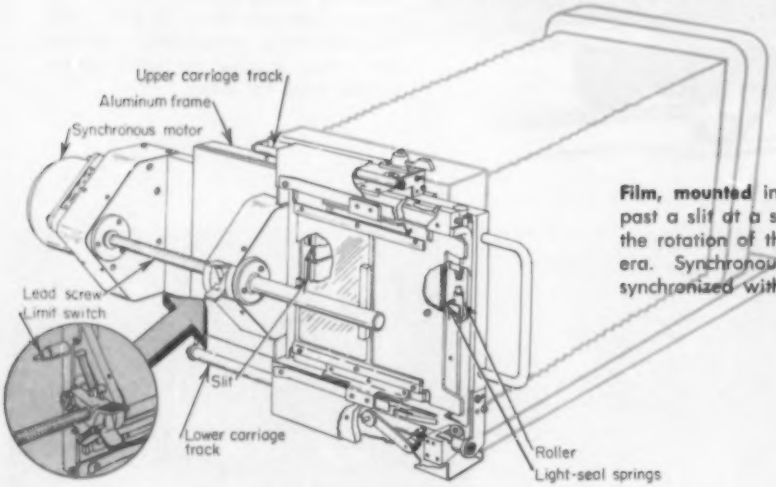


Traversing Plate Scans 360-deg Surface

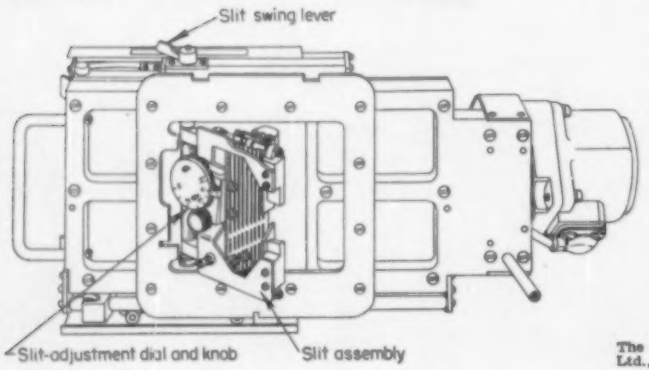
REFLECTIONS, viewing angles, and focal-plane problems limit the effectiveness of ordinary pictures of a cylinder. A new periphery camera "unwraps" a cylinder and allows its total surface to be seen in one view. It can make acceptable pictures of tires, engine pistons, or even a fingerprint wrapped around a pencil.



As the subject turns clockwise, the image of any point on it moves in the direction of the traverse arrow. The image must move at the speed of the plate. There is one magnification, v/u that satisfies this condition. If the circumference of the object is $2\pi r$, the length of the image is $2\ \pi r\ v/u$ and this must equal the traverse of the plate, t. Points at any other radius, R, will appear as lines instead of points. When the slit is sufficiently narrow, the camera can photograph a sufficient range of radii for most applications.



Film, mounted in a traversing carriage, moves past a slit at a speed that is synchronized with the rotation of the subject in front of the camera. Synchronous motor driving the carriage is synchronized with the turntable motor.

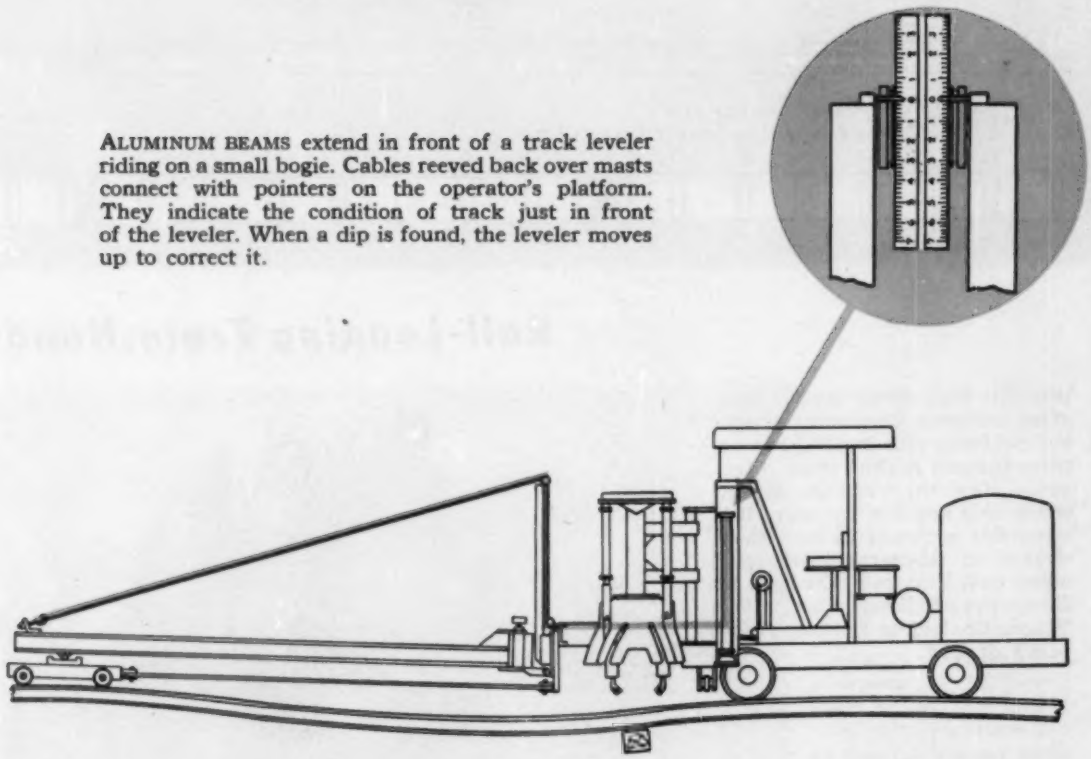


Slit jaws are mounted on a spring-loaded, swinging frame. The spring holds the frame against an adjustable stop that keeps slit jaws about 0.001 in. from the film. Using the swing lever, the operator can swing the slit into the camera out of the way while changing film.

The periphery camera was developed by Shell Research Ltd., Thornton Research Centre, Chester, England.

Extension Bogie Spots Rail Dips

ALUMINUM BEAMS extend in front of a track leveler riding on a small bogie. Cables reeved back over masts connect with pointers on the operator's platform. They indicate the condition of track just in front of the leveler. When a dip is found, the leveler moves up to correct it.

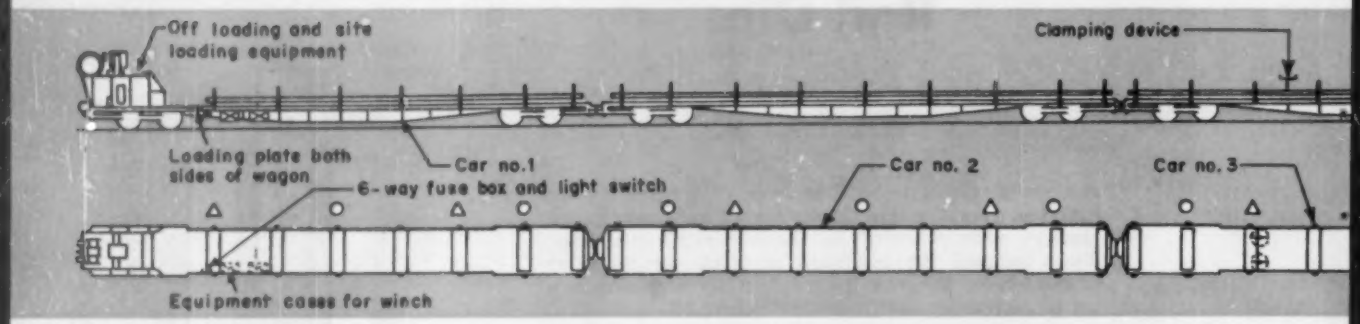


Beams move independently and record level of each rail on indicators in front of the operator. Track is lifted by hydraulic clamps, and ballast is tamped under the low spot. Operator's controls can actuate clamps and tampers on either side, or both together.



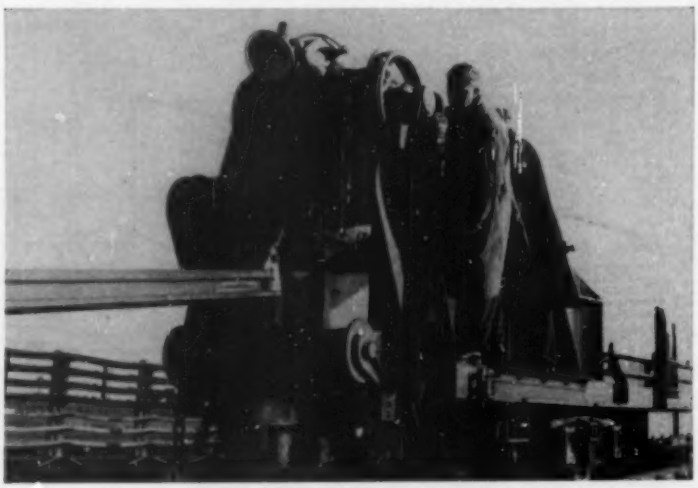
Jacking tamper with the leveling device was developed by Railway Maintenance Corp., Pittsburgh.

British Railways Design



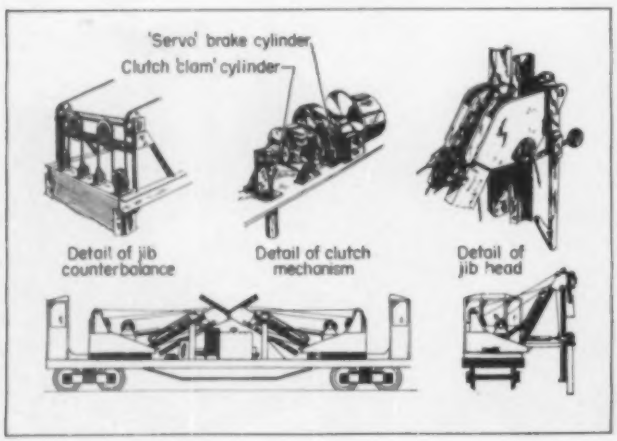
Rail-Loading Train Handles

WELDED RAIL poses special handling problems. Ordinarily removing the 300-ft rails involves cutting them up and loading them piecemeal. Now they can be loaded whole on a new five-car train. It is especially equipped to haul them aboard or discharge them from either end. The train was built by Gloucester Railway Carriage & Wagon Co. Ltd. to London Transport's designs.



Winch hoists a rail until the train can be moved under it. Rollers are provided at each end of the train to assist in moving rails on and off. The winch is at the forward end.

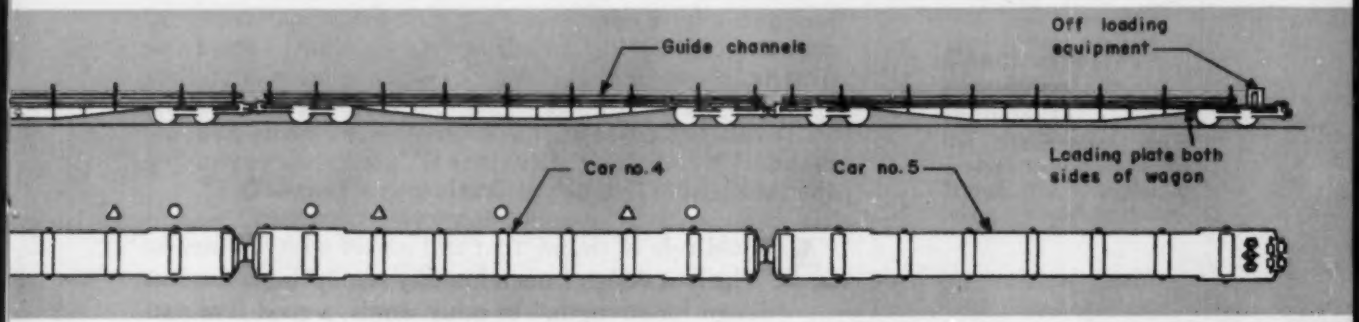
Rail-Mounted Pile Driver



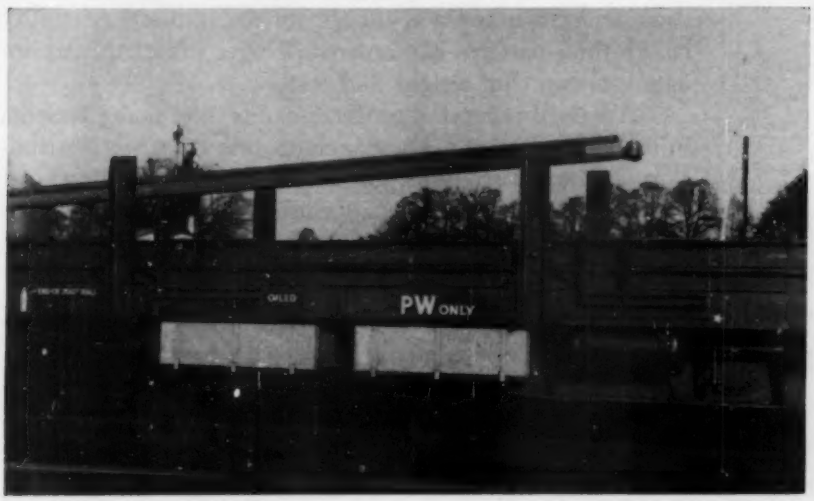
PRECAST concrete posts will support wire conduit along Britain's northeastern railways. The posts are carried, positioned, and set by a special train consisting of a pile-driving car and a crane car with carrying space for the posts. The equipment was developed under the Chief Civil Engineer, North Eastern Region, and constructed in the regional workshops at York.

Engine in the center of the car drives hydraulic units for both drop hammers and a 1-kw generator that powers floodlights for night operation. Each pile-driving unit is mounted on a turntable and rotates 90 degrees. Winches and turntables are run by hydraulic motors. Other linkages are actuated by hydraulic pistons.

Labor-Saving Special Trains



300-ft Welded Lengths

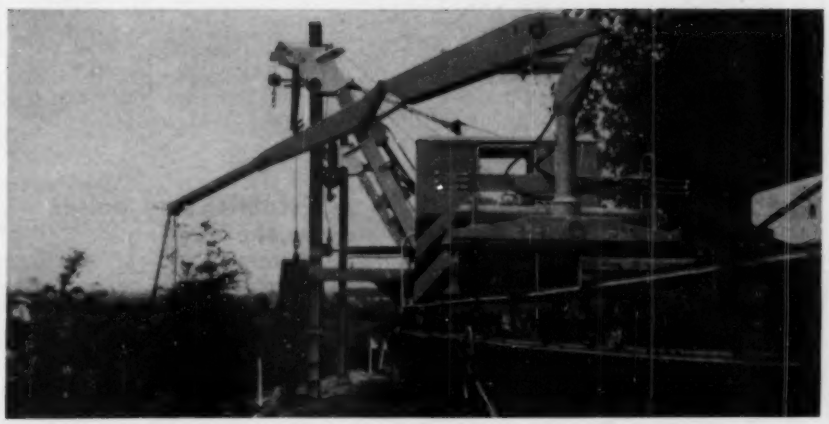


Rails are rigidly fastened only at the car number three. Free end play is allowed to insure the least possible stress as the train passes around bends and curves. Three layers of rails are carried on triangular bolsters. Guide channels keep the rails in line with the cars.

Roller, temporarily mounted on the leading end of the rail, contacts the guide channels to keep the rail in line as it moves aboard. The other end of the rail butts a stop fastened to a convenient tie. The winch will be used again to haul the last 20 ft of rail aboard.

Sets Concrete Posts

Hydraulic pistons flex the joints of the crane used to deliver the concrete posts. The crane lays the posts along the right of way. A line from the pile-driver framework fastens to the post and pulls it upright when the pile driver is ready to set it.



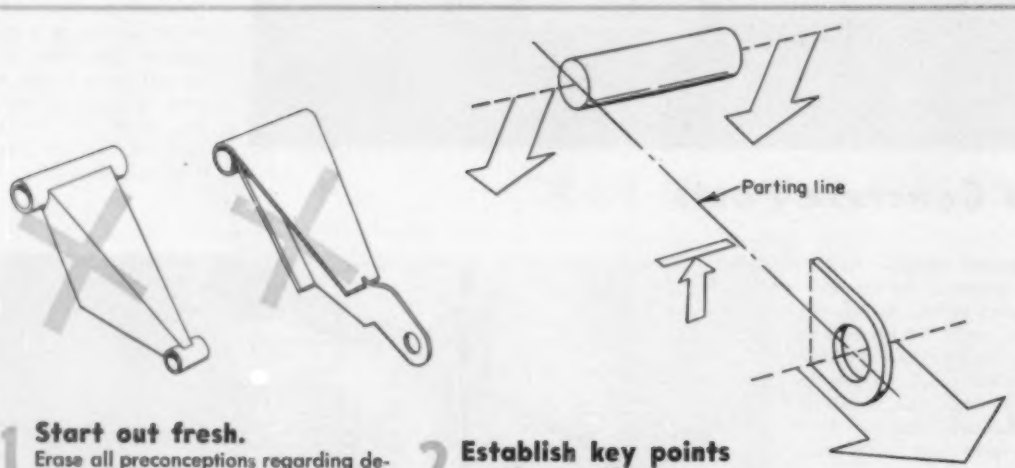
Seven steps in designing
minimum-weight castings

Malleable iron combines two virtues: High strength, plus the ability to be cast in thin sections. Used together, these properties can result in weight reduction—if the casting is designed properly. Reduced to seven basic steps, here are the methods recommended by a design engineers' panel surveyed by the Malleable Founders Society.

AN old rule of thumb that still makes a lot of sense is: "The best design from a foundry standpoint is the best design for strength." In other words, a good flow pattern for molten metal usually results in an effective casting shape for distributing in-service loads or stresses.

Modern malleable casting design uses experimental stress analysis to test actual parts for strength and reliability before final patterns are ordered. Proper use of this up-to-date tool can trim weight and cost.

A weight-reduction program can lead to many benefits in malleable castings. These include uniform stress distribution, additional strength, lower foundry and shipping costs and, in many cases, better appearance. The following steps can play a major role in meeting these objectives:



1 Start out fresh.
Erase all preconceptions regarding design of the part. For example, don't limit thinking to straight sections.

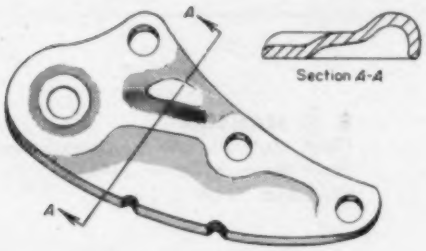
2 Establish key points on the casting.
Locate terminal and mating parts. Visualize how the parting line should run for best part design and foundry techniques.



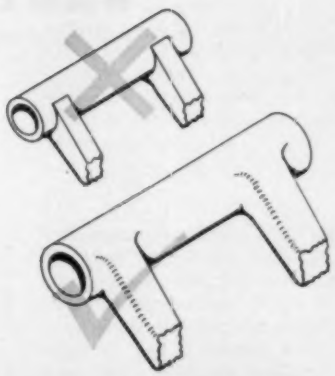
3 Connect key points.
Consider directions and magnitudes of service stresses when connecting the various terminal points.



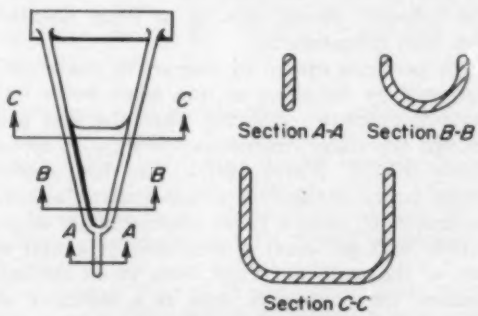
4 Check stresses at critical locations.
Use experimental stress analysis techniques (brittle lacquer, for example) to refine the casting design.



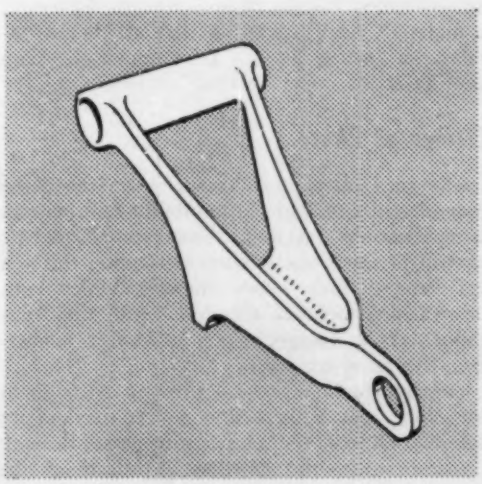
5 Strengthen with ribs, corrugations, dimples.
These simple shapes add greatly to strength, yet cost little in a cast part. Ribs should be used only in compression. Corrugations should be aligned along primary stress direction. Dimples should be oval in shape, with major axis of oval along the direction of stress.



6 Smooth out sharp corners.
Use fillets and radii instead of sharp corners to promote metal flow and avoid stress concentration.



7 Make sections uniform.
Wall thicknesses in a malleable casting are usually from ¼ to 2 in. Sections should be designed to promote directional solidification toward the feeding head, thus insuring proper cooling and heat transfer.



The final casting design.

A designer's guide to

THERMAL

PART 1 — BASIC SUITABILITY

S. S. MANSON
Chief, Materials and Structures Research Div.
Lewis Research Center, NASA
Cleveland, Ohio

BASIC suitability of a material for a given application is the first requirement to be considered in material selection. Strength, ductility, oxidation, and corrosion resistance at operating temperatures and pressures are primary considerations which require little comment. However, some materials have properties that are fairly uncommon, but which have a pronounced effect on material behavior under thermal stresses.

● Change of Phase

Metallurgical instability of some materials in the use range results in basic unsuitability for thermal-stress applications. Among these instabilities are changes of phase as the temperature passes through critical values. Such phase changes, which consist of rearrangement of the atoms into new configurations, cause changes in volume, and in temperature coefficient of expansion.

If temperature changes are uniform throughout the structure, and if there is complete freedom for change of volume as the temperature passes through the critical value, the detrimental effects of the phase change are avoided. But in most cases, one portion of the structure passes through the critical temperature earlier than the others. High stresses can be developed as the transformed material seeks its equilibrium volume in the presence of the untransformed material.

Many common problems are associated with phase changes, particularly if high temperature gradients are also present. One example is the cracking of steel cylinders during heating or rapid quenching from high temperatures.

The problems caused by changes in phase can be illustrated by the effect on iron when ferrite transforms to austenite, occurring when the iron passes through the transformation temperature of approximately 1680 F. Above 1680 F, the body-centered ferritic lattice changes to a face-centered austenitic configuration, with a linear contraction of approximately 0.35 per cent on each side of a unit volume of the material. Thus, even at an essentially constant temperature, if there is a sufficient temperature fluctuation to cause transformation of the surface of a cylinder, the surface undergoes a strain of 0.35 per cent if it is prevented from contracting. Assuming a modulus of elasticity = 20×10^6 psi, and Poisson's ratio = $\frac{1}{3}$, the nominal elastic stress = 105,000 psi. Because of plastic flow, this stress may not actually be developed. But the effect is obviously severe.

The same problem occurs in the welding of steels.

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STRESSES

OF MATERIALS

Choice of material in designing for thermal-stress applications is based on many factors, among them producibility, cost, fabricability, and performance. The first three factors usually require relatively little information and analysis. On the other hand, material performance is of great concern to the designer, and requires considerable attention.

In the early stages of the design, all available materials must be carefully screened, leaving for final consideration only those which seem to be best suited. The best procedure is to base initial considerations on general, usually qualitative, material characteristics; consideration of detailed performance is reserved only for the most promising materials.

In addition to specific material performance, there are two main factors to consider in evaluating materials for thermal-stress applications:

Basic Suitability. Some materials have characteristics that make them basically unsuitable for applications involving thermal cycling, particularly when nonuniform temperatures are involved. Recognition of these basic difficulties often helps to avoid unexpected complications. In many cases, composition and processing variables can be selected to permit use of a material which otherwise might be completely unsatisfactory.

Comparative Suitability. Whereas several materials might be basically suitable for a given application, the relative suitability of one may far exceed that of the others. But while a detailed analysis of the performance of each material would indicate relative suitability, a completely detailed analysis is not always necessary. Thermal-shock parameters have already been used in rating brittle materials. Such parameters can be useful for steady-state application of brittle materials, and qualitatively at least, parameters can be devised for comparing ductile materials as well.

PART 2

During welding, the heated section may be in the austenitic range, and the geometry fixed by the free lengths at welding temperatures. Cooling causes dimensional changes, both because of temperature change and phase change. Fortunately, the effects are in opposite directions, the lattice expanding as it changes to ferritic and contracting because of the temperature reduction. However, cracking still occurs quite often.

Improvement by Stabilization: In many cases the phase-change problem is inherent, and the solution lies in avoiding temperature ranges involving phase changes, or in avoiding materials which are subject to these effects. Sometimes, however, it is possible to control the problem through engineering and metallurgical techniques.

A convenient method of eliminating phase transformation, sometimes called an inversion, is to combine the metal with an oxide, Fig. 1.[1,2] The original metal is then said to be stabilized. However, while complete stabilization eliminates the inversion, it is not altogether desirable from the standpoint of thermal shock, primarily because the associated high coefficient of expansion reduces thermal-shock resistance. The ideal composition is one that offers

PART 3

PART 4

Next to the choice of proper material, the most powerful tool available to the designer who must contend with the effects of thermal stress is the choice of design configurations. Often, however, the principles upon which the choice must be made are opposed to those involved in designing for mechanical loading. Thus, making sections more bulky frequently reduces operating stresses under mechanical loading, but this approach may do more harm than good under thermal loading.

Methods are available to offset the harmful effects of thermal stresses. These methods include: Reducing constraints, minimizing nonuniform expansions, introducing beneficial residual stresses, avoiding strain concentrations, providing adequate surface protection.

[1]References are tabulated at end of article.

adequate stability, and in which changes in expansion characteristics are gradual.

Improvement by Metallic Additions: Another method of coping with the phase-change problem is the addition of another metal, Fig. 1. In addition to providing metallurgical stabilization, the metal increases thermal conductivity, thus reducing temperature gradients.

• Anisotropic Expansion

Most of the materials used in engineering are reasonably uniform in their directional thermal-expansion properties. However, noncubic metals, such as cadmium and zinc, have long been recognized as thermally anisotropic. When a crystal of one of these materials is heated, different expansions occur in each of the crystallographic directions. Bodies of such materials, consisting of juxtaposed crystals having different orientations, thus develop internal stresses due to nonuniform expansion, even when the entire body is at uniform temperature.

From an engineering standpoint, this problem has not been acute because of the limited application of the noncubic metals for structural uses. The recent addition of the noncubic metal uranium to the structural metals used in nuclear technology has, however, focused attention on the situation. Problems arose early in the development of metallic-uranium components when exceptionally large changes in shape were noted during thermal cycling, and many investigations were undertaken to determine the cause of this undesirable behavior.[3-7] To understand this behavior, and to guard against it, it is helpful to study the mechanism of the process revealed by these investigations.

Mechanism: The basic mechanism involved in anisotropic expansion seems to be related to a type of thermal-ratchet similar to that already discussed[8] except that no external load is required to cause progressive distortion during cycling. The basic factors involved in the mechanism appear to be:

1. Directional anisotropy of thermal expansion. The crystals of a polycrystalline specimen expand different amounts in a given direction even when the entire specimen is at a uniform temperature, thus generating thermal stresses.
2. Directional anisotropy of strength, or resistance to plastic flow. Crystals so oriented that the induced shear stresses are high on planes readily susceptible to slip will flow plastically, while more favorably oriented crystals may be able to resist the stress by elastic extension.
3. Dependence of the strength of crystal interface on temperature and strain rate. Above a certain temperature, the restraint on expansion of adjacent crystals via the interface becomes limited. As in all high-temperature creep, the higher the strain rate, the greater the resistance to flow. At temperatures well below the critical temperature, the strength of the interface is high, and load is readily transmitted through it.

The effect of thermal ratchet on a hypothetical specimen is shown in Fig. 2. Crystal *A* is a concentric cylinder surrounding crystal *B*, Fig. 2*a*. Crystals are so oriented that plastic flow can readily occur in the slip planes of crystal *B* under axial loading. The slip planes of crystal *A*, however, are oriented to resist slip under axial loading. Because of the orientation of its slip planes, crystal *B* has a higher coefficient of expansion in the axial direction than does *A*.

For simplicity, reference temperature is taken as T_c, which is also the critical temperature. As temperature drops, *B* contracts more than *A*, causing tensile stress in *B*. When the yield stress in *B* is reached the stress no longer increases, but elongation still takes place in the form of plastic deformation, changing the natural length of *B*. At T_c the crystal interface loses strength, eliminating the "grip" of *A* on *B*. For the period that the temperature is greater than T_c the two crystals act as separate entities with little interaction between them, but as the temperature is again lowered below T_c the "grip" reforms,

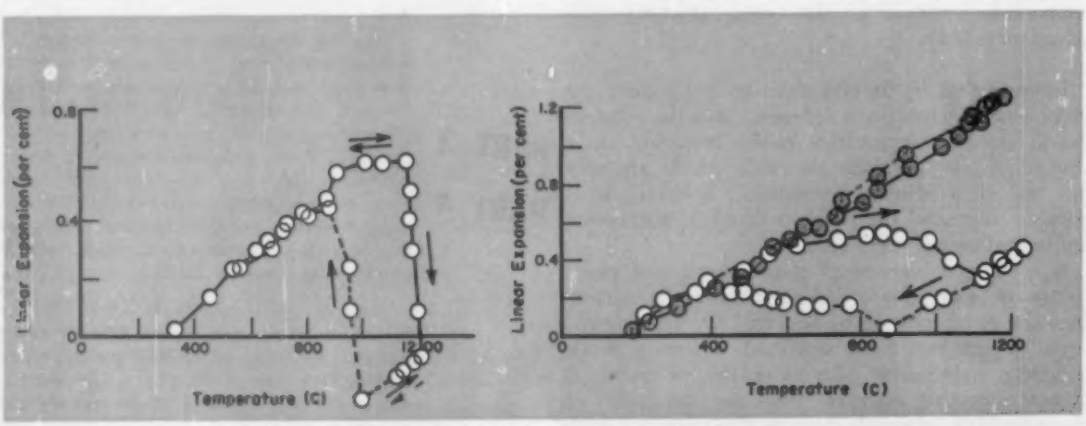


Fig. 1—Thermal-expansion curves for unmodified zirconia, *a*, and for zirconia specimens containing an oxide, CaO, as a stabilizer, *b*. The addition of oxides and, in some cases, metals is a convenient method of eliminating phase changes, or inversions. Such inversions can produce extremely high induced stresses.

and new deformation takes place, this time starting from the new base length that had been established on *B* after its plastic flow Fig. 2*b*. The action is like a ratchet, in which the significant motion is always in the same direction, the load relaxing during the period that the mechanism pauses to resume the unidirectional motion. In this case the significant motion is the plastic elongation of crystal *B*.

The difference in size between *A* and *B* thus becomes progressively greater with each temperature cycle. When this phenomenon is repeated many times in a complex of numerous interacting crystals, the result produces surface texturing, internal holes, and overall growth and distortion.

Mitigation: There are several ways to relieve the thermal-ratchet growth problem. Randomization of grain directions is helpful. This can best be achieved by using a fine grain size. Such control of the metallurgical structure can be obtained by heat treatment, and by controlling the variables in mechanical working; for example, temperature during rolling.[7]

While the shear resistance of the grain boundary has been assumed to be zero, this is obviously just an idealization. Actually, the release of restraint by adjacent grains at the critical temperature is a creep phenomenon, and it has been found[8] that for a given cyclic temperature range, maximum growth rates occur with slow heating and fast cooling. When the heating is fast and cooling slow, less growth is possible, and more reverse creep probably occurs during the cooling, resulting in small net growths. In general, the greater the temperature range and the higher the peak temperature, the greater the growth.

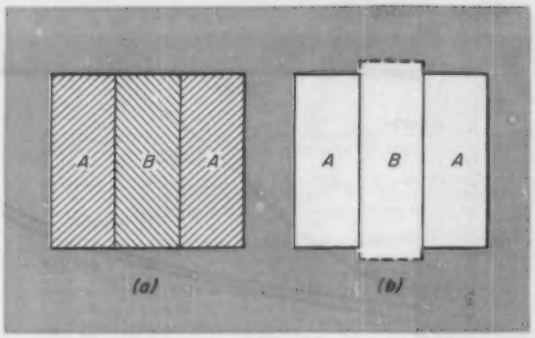


Fig. 2—Effect of thermal ratchet on a pair of crystals. During each thermal cycle crystal *B* grows progressively larger than *A*. This condition can cause a textured surface, or holes in the material.

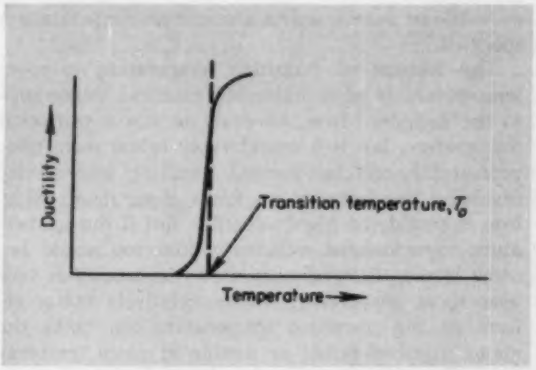


Fig. 3—Variation of ductility in region of the transition temperature. Below transition temperature, ductility may be low, but near this temperature, ductility rises sharply.

● Extreme Brittleness

Some metals and ceramics are sometimes extremely brittle, and should be avoided in thermal-stress applications where strains are large enough to cause rupture. Ductility can usually be imparted to a metal once its characteristics are understood, but it cannot be assumed that all metals are ductile. On the other hand, a material that normally is not ductile can sometimes be made so by careful attention to metallurgical structure and chemical composition.

Brittleness is of great importance in the metal-ceramic combinations known as cermets, in the light metals titanium and beryllium, and in the refractory metals such as chromium, molybdenum, and tungsten.

Transition Temperature: Many materials, such as tungsten and molybdenum, which are frequently characterized as brittle have a "transition temperature," above which there is a marked increase in ductility. The effect of temperature on ductility is illustrated in Fig. 3. Below the transition temperature ductility may be very low, or even zero, but in the vicinity of transition temperature T_o ductility rises sharply. Thus, since ductility depends on tem-

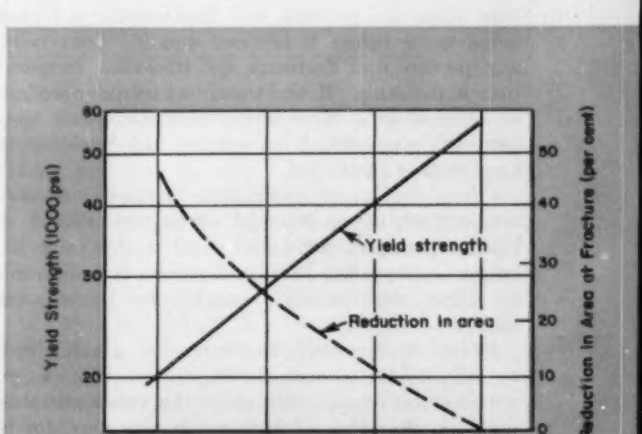


Fig. 4—Effect of strain rate on flow strength and ductility of annealed tungsten at 480 F. The material changes from wholly ductile to brittle as strain rate is increased.

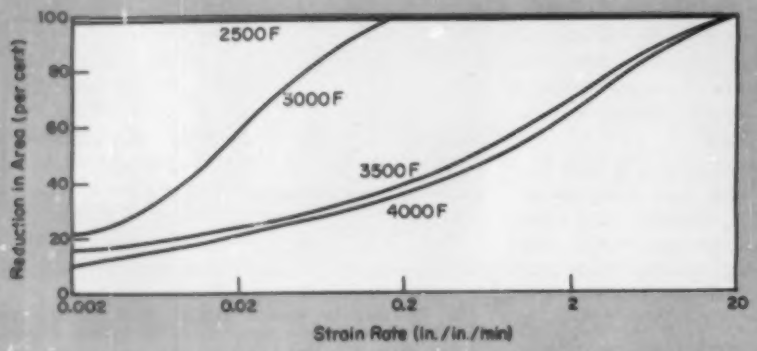


Fig. 5—Effect of strain rate on ductility of tungsten at temperatures from 2500 to 5000 F. In this elevated temperature range, which is well above transition temperature, ductility increases with an increase in strain rate—apparently because at these elevated temperatures mode of failure is transcrystalline rather than intercrystaline.

perature, a material should not be classed either as brittle or ductile unless a reference temperature is specified.

The relation of transition temperature to room temperature is of considerable practical importance to the designer. Iron, for example, has a transition temperature, but it is considerably below room temperature; hence, for normal handling and service involving temperatures no lower than room value, iron is considered highly ductile. But if the temperature were lowered sufficiently iron too would become brittle. Molybdenum shows its transition very near room temperature; hence, relatively minor effects on the transition temperature can make the material either brittle or ductile at room temperature. Tungsten, on the other hand, has a relatively high transition temperature, ranging up from 400 F.

Process: The effect of a process on a material can be measured in part by its effect on the transition temperature. Any change that causes the transition temperature to increase is, of course, undesirable, since the material will then require a higher temperature before it becomes ductile. Conversely, any process that decreases the transition temperature is desirable. If the transition temperature can be reduced to a value lower than the lowest temperature encountered in service, the problem of brittleness is eliminated.

Often, the lowest temperature of interest is room temperature, since practical parts are handled at this temperature, and usually cool to this value between service runs. Ideally, therefore, it is desirable to reduce the transition temperature below room value.

Strain Rate: High strain rate, as a rule, tends to increase the transition temperature, Fig. 4. At temperatures considerably above the transition value, however, the effect of high strain rate may not be detrimental to the ductility of the material, Fig. 5.[9] It is primarily upon return to the lower temperatures in the vicinity of the transition value that high strain rates may be troublesome.

Cold Work and Recrystallization: Another important factor affecting transition temperature is cold working. If the annealed material is worked at a low temperature, ductility is increased in some temperature ranges; in particular, the temperature at which ductility vanishes may be appreciably lowered. The beneficial effect possibly is due to a system of residual stresses set up by the cold working in the broken-up crystallite boundaries. However, if the temperature of the material is raised to a value that causes the crystalline structure to realign itself (recrystallize), and thus reduce the residual-stress system, the beneficial effect on the transition temperature may disappear.

Purity: In general, the purer the material, the lower the transition temperature. Evidence indicates that there is great promise of improvement in the ductility of materials such as tungsten, normally highly brittle at room temperature, by purification.

Alloying: In some cases, alloying reduces transition temperature. Rhenium, for example, has been found to increase greatly the ductility of tungsten.[11] While rhenium is rare and costly, and large additions are apparently required to produce beneficial results, its use may be justified in very special applications. Studies are being conducted to reduce the amount of alloying element required to impart ductility. But the underlying principle shows promise.

Surface Smoothness: Brittle materials such as tungsten are highly notch-sensitive. Hence, ductility can be considerably improved by eliminating, as much as possible, surface imperfections.

Conclusion: In assessing nominally brittle metals for thermal-stress applications it is important to remember that some ductility is usually available at temperatures above the transition value. Thermal shock by sudden heating usually involves compressive stresses, when temperatures are high. For such applications, therefore, it can be expected that the requisite plastic flow will be absorbed during the heating portion of the cycle. The danger in such applications lies in the residual tensile strains that are induced, upon return to low temperature, by the plastic compression that occurred at the high temperature. If these strains require plastic flow at a temperature below that of transition, failure can be expected during the return portion of the cycle.

On the other hand, if the lowest temperature of the cycle can be kept above the transition temperature, then brittle failure may be averted, and interest need be concentrated only on the possibility of thermal-stress fatigue.

Applications involving sudden cooling from a high temperature frequently involve tensile plastic flow before the temperature falls below the transition value. The induced residual compressive stresses then develop when the temperature equalizes at the low temperature, or when the part is slowly heated to a uniform high temperature. The situation is not as serious as in sudden heating, because even if the lowest temperature in the cycle is below transition, the compressive residual strains are likely to be more readily absorbable than tensile strains. Also, the transition temperature for compression is lower than that for tension. If at all possible, however, the lowest temperature should be kept higher than the transition value for tensile stress. This can be done either by keeping the transition temperature low, or by never allowing the part to cool completely if transition temperature is above room temperature.

Part 2 of this series will discuss the comparative suitability of materials under thermal stress.

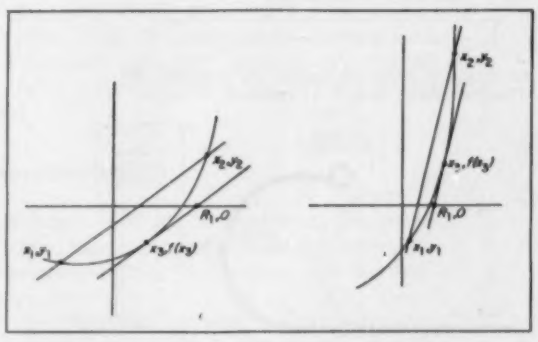
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Tips and Techniques

Finding Roots of Equations

The following method may be used to quickly find the root of any equation in which the exponents are integers and not greater than 3. In using the following steps, it is often helpful to sketch the graph of the equation in the region where it crosses the x axis, as shown.



1. Write the equation in the form $y = f(x)$.
2. Locate two points, one above and one below the x axis, and find the slope, m, of the line that joins these two points; $m = (y_1 - y_2)/(x_1 - x_2)$.
3. Make $f'(x) = m$, where f' is the first derivative of the original equation. Solving this expression gives x_3, the abscissa of the point $[x_3, f(x_3)]$, where the line with slope m is tangent to the curve $y = f(x)$.
4. Find $f(x_3)$ by substituting x_3 into the original equation.
5. Find R_1 from $R_1 = x_3 - [f(x_3)/m]$.
6. Calculate $f(R_1)$ by substituting R_1 into the original equation, then $f'(R_1)$ by substituting R_1 into the first derivative of the original equation.
7. Find R_2, a refinement of root R_1, from $R_2 = R_1 - [f(R_1)/f'(R_1)]$. This is Newton's method for approximating roots of $y = f(x)$, and may be applied for successive approximations to any desired degree of accuracy. For example, $R_3 = R_2 - f(R_2)/f'(R_2)$, etc.
8. Check the accuracy of the refined root by substituting R_2 into the original equation. This is done for each successive refinement.

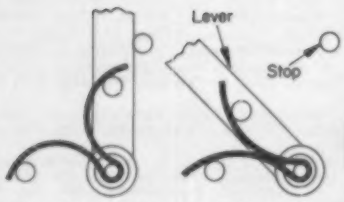
The point $[x_3, f(x_3)]$ may fall above or below the x axis, as shown. Neither condition affects the accuracy of the method.

Example: Find a root of $x^3 + x = 1$.

1. Let $y = f(x) = x^3 + x - 1$.
2. Locate two points, above and below the x axis. Thus, with $x = 0$, $y = -1$; with $x = 1$, $y = 1$. Then, $m = (-1 - 1)/(0 - 1) = 2$.
3. Differentiate the original equation, so that $f'(x) = m$ or $3x^2 + 1 = 2$. From this, $x_3 = 0.57735$.
4. Find $f(x_3)$, by substituting into the original equation, giving $f(x_3) = -0.23020$.
5. Find $R_3 = 0.57735 - (0.23020/2) = 0.69245$.
6. Finally, substituting R_1 for x in the original equation, $f(R_1) = 0.2447$; substituting R_1 in the first derivative of the original equation, $f'(R_1) = 2.4384$.
7. Define R_1, with $R_2 = 0.69245 - (0.2447/2.4384) = 0.68245$.
8. Check the approximation R_2 by substituting R_2 for x in the original equation. Thus, $f(R_2) = 0.00029$. This is a very close approximation, since $f(R_2)$ yields 0 to three decimal places.—RAYMOND C. BOUCHER, *Stratford, Conn.*

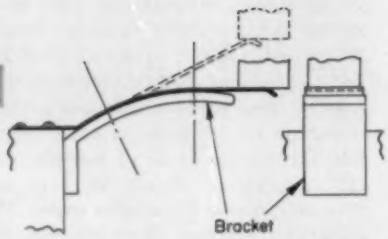
8 *ways for providing uniform or varying spring rates with* FLAT SPRINGS

L. KASPER
Engineering Consultant
Philadelphia, Pa.

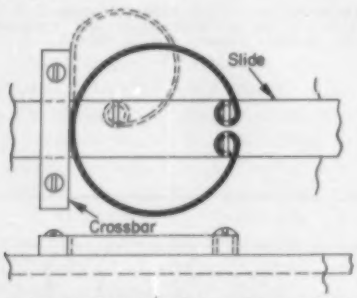


Initial spring rate is relatively small. When the lever is moved to positions where the legs of the spring are forced together, effective length is reduced and spring rate becomes much greater.

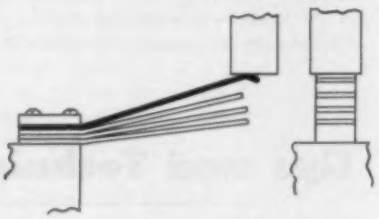
Increasing Spring Rate



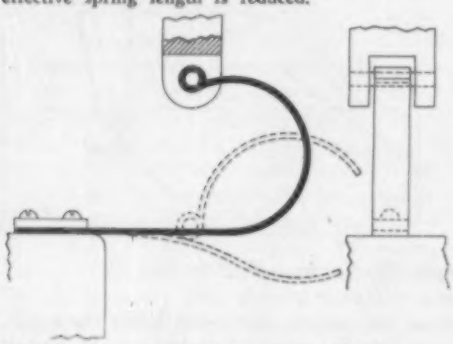
As spring wraps around the curved bracket, its effective length is reduced, thus causing an increase in spring rate.



As spring is flattened against the crossbar, the effective spring length is reduced.

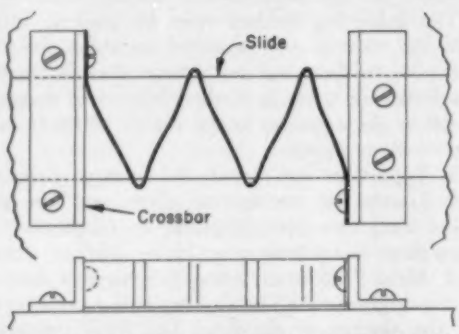


Additional resistance to deflection is provided by each spring leaf as it is contacted.



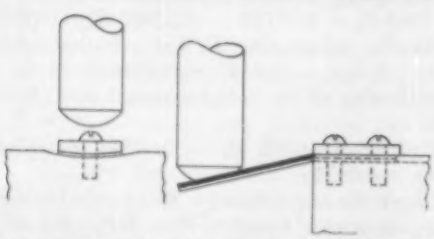
Resistance is slight until the end of the loop contacts the straight portion of the spring. Then, resistance is greatly increased.

Uniform Spring Rate

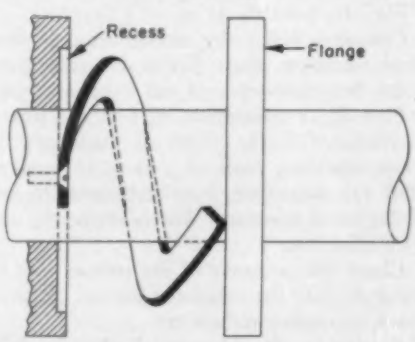


This spring is active over a long distance but folds into a small space. The slight curves, which must be designed to suit material thickness, produce nearly uniform action throughout the range of movement.

Decreasing Spring Rate



Dished cantilevered spring provides relatively high spring rate until the dish buckles. Thereafter, action is the same as with a flat spring except that bending occurs only at the edge of the supporting surface.



A flat ring is split and stretched into a helix before heat treatment. Movement of the flanged shaft compresses the spring into a shallow recess.

Water-Glycol Hydraulic Fluids

Since water will not burn and is relatively inexpensive, it has obvious advantages as a fire-resistant hydraulic fluid. However, to overcome the inherent limitations of water alone, glycol and other additives are required.

This fourth and concluding article of a group on hydraulic-fluid selection discusses these water-glycol solutions. Earlier articles* discussed emulsion, petroleum, and synthetic fluids.

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ONE of the mostly widely used fire-resistant hydraulic fluids is the water-glycol type. In general, this fluid is a solution composed of water, a glycol, a synthetic thickener, and additives which impart lubricity and control corrosion of metal parts. Water-glycol fluids are described as snuffer-type materials. Their fire-resistance is derived from the water content, generally between 35 and 50 per cent. Table 1 lists typical properties of a water-glycol fluid.

Fluid Characteristics

Fire-Resistance: Methods for measuring fire resistance of fluids include spray-flammability, hot-manifold, compression-ignition detonation, and auto-ignition tests.

In the spray-flammability tests, a fluid is sprayed at various pressures through ignition sources such as gas flames, electric sparks, or oxyacetylene flames. These tests simulate the common type of in-plant hazards. In all of these spray-type tests, the water-glycol fluids with their original water content, will not ignite. If the water content has been reduced

*See bibliography at end of article.

Table 1—Fluid Properties

Weight (lb per gal)	8.80
Specific gravity at 60/60	1.05
Water content (per cent)	40
Alkalinity, pH	8.5
Specific heat (Btu per lb per deg F)	0.8
Thermal conductivity (Btu per hr per sq ft per deg F per ft)	0.25
Viscosity index	140
Pour point (deg F)	−20
Flash point	*
Fire point	*

*Cannot be determined by ASTM procedure.

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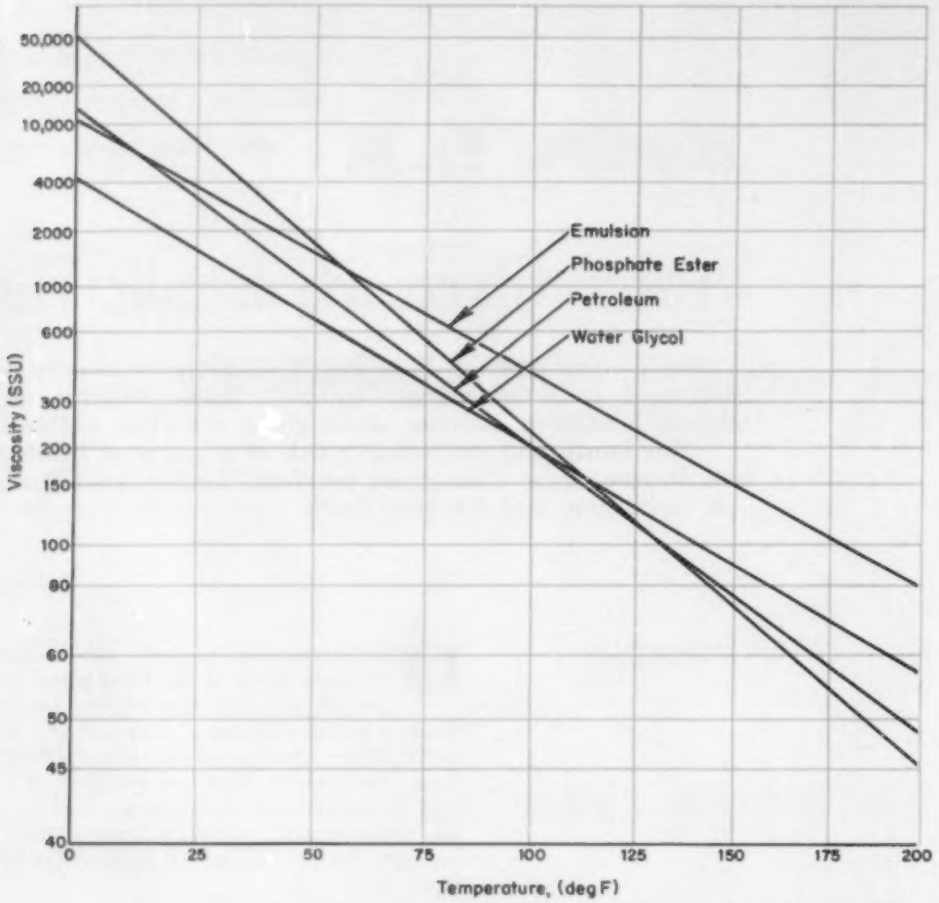


Fig. 1—Viscosity-temperature relationship for the principal types of hydraulic fluids.

by continuous evaporation or prolonged exposure to elevated temperatures, the residual fluid can be ignited.

If the fluid is poured onto a hot manifold or onto molten metal, the water will boil off and the residue may burn with a low flame. However, the flame will be confined to the immediate source of the high temperature.

The water-glycol fluids also offer a high factor of safety in applications where compression ignition is a potential hazard or where liquid oxygen is present. In general, of all the fire-resistant fluids, the water-glycol fluids are more difficult to ignite under all of these conditions.

Viscosity: Water-glycol fluids are generally available in a viscosity range of 150 to 300 SSU at 100 F. Their viscosity-temperature characteristics are excellent, Fig. 1. Normally, they have a viscosity-index of approximately 140. Design of hydraulic systems usually limits the viscosity of the fluid to a maximum of 4000 SSU. The high viscosity index of the water-glycol fluids makes them particularly suited to systems which may be partially exposed to low ambient temperatures.

The viscosity of water-glycol fluids does not break down under the severe mechanical shearing action of pumps and valves in hydraulic systems. Changes in water content will cause variances in the viscosity. The rate of change in viscosity depends upon the original water content of the fluid. Thus, in service, the water content should be measured at regular intervals.

Oxidation Stability: The major components of water-glycol fluids resist oxidation as long as the fluids are alkaline. Generally, no chemical breakdown will occur as long as the pH of the fluid is above 7.5. Maintenance of the proper alkaline content is also required to prevent depletion of the additives contained in these fluids.

Lubricity: When water-glycol fluids were first introduced, the effect of the apparent lack of lubricity upon pump life was questioned. Subsequent field experience has demonstrated that these fluids can operate successfully in many types of pumps, if the equipment is operated in accordance with both the fluid and pump manufacturers' recommendations concerning pressure and temperature limitations. Many systems have operated up to seven years without replacement of pumps.

Table 2—Bulk-Modulus Comparison

Pressure (psi)	Bulk Modulus (psi)	
	Water-Glycol	Oil
2000	309,000	250,000
3000	315,000	261,000
4000	327,000	267,000
5000	330,000	270,000
6000	332,000	279,000
7000	334,000	283,000
8000	335,000	286,000
9000	337,000	287,000

Design Considerations

Pumps: Some types of pumps will operate successfully with water-glycol fluids. Others may be marginal or not satisfactory for use with these fluids. The following general rules can be applied if it is recognized that exceptions to them may exist:

1. Since balanced vane pumps have negligible bearing loads, little or no difficulty is encountered when they are operated with water-glycol fluids.
2. Axial piston pumps, in general, have adequate bearing capacity for use with water-glycol fluids.
3. Most gear-type pumps constructed with antifriction bearings do not provide adequate bearing capacity for water-glycol fluids. However, gear pumps equipped with plain bearings operate satisfactorily with water-glycol fluids.
4. In general, water-glycol fluids are not recommended for operation in radial piston pumps.
5. Screw type pumps operate satisfactorily with water-glycol fluids.
6. A number of pumps which normally contain antifriction bearings that do not operate satisfactorily with water-glycol fluids can be modified to operate successfully by substituting plain bearings or higher capacity antifriction bearings.

Strainers and Filters: To reduce excessive downtime, maintenance costs, and pump or valve failures, all hydraulic fluids should be kept clean. This factor becomes more important as the complexity of a hydraulic system increases.

It is normally recommended that 60-mesh suction strainers, or filters having twice the pump capacity, be used with water-glycol fluids. Finer mesh filters can be used on the suction side of the pump if total filter capacity is sufficient to permit adequate fluid flow to the pump under start-up conditions. The water-glycol fluids have higher densities than oil. Therefore, larger diameter piping may be required to obtain proper flow to the pump. Suction filters should be readily accessible to facilitate periodic inspection and cleaning.

In hydraulic systems containing divider valves or servomechanisms, very fine filtration is required to prevent sticking or scoring of these components. Full-flow or by-pass filters in the return line should be used to insure adequate cleanliness. Water-glycol fluids will pass through 5-mu filters.

Since water-glycol fluids are alkaline, they should not be used with filter elements containing zinc or cadmium. Adsorptive filters, such as clay and fuller's earth, should not be used since they will remove the additives from water-glycol fluids.

Paints and Pipe Dopes: Special paints and pipe dopes must be used with water-glycol fluids. Materials that are normally used with petroleum oil will be dissolved by water-glycol fluids.

Packings and Seals: Water-glycol fluids are generally compatible with rubber packings and seals. They should not be used with cork. Leather-packings must be evaluated specifically for each application.

Bulk Modulus: The bulk modulus of water-glycol fluids, Table 2, shows that they are less compressible than a comparable petroleum oil.

Heat Transfer: Water-glycol fluids have the highest specific heat among the currently available types of fire-resistant fluids.

Compatibility: Water-glycol fluids are not compatible with other hydraulic fluids. Oil will float on top, whereas phosphate ester and other high specific-gravity fluids will settle to the bottom. Water-glycol fluids will cause emulsion fluids to separate.

Metals: The water-glycol fluids are compatible with most metals. However, they should not be used with zinc or cadmium. For best results, aluminum should be anodized. Since these fluids contain a substantial amount of water, their use in systems handling magnesium is not recommended.

Operating-Temperature Range: Water-glycol fluids are available for operation at temperatures down to −65 F. The maximum permissible temperature of these fluids at the pump inlet is generally considered to be 120 F. However, they can be used at temperatures of 150 F and, in some isolated instances, even higher. At temperatures above 120 F, tight reservoir covers should be provided to minimize the loss of water through evaporation. The viscosity of the fluid will increase with a reduction in water content. When abnormal loss of water occurs, the fire-resistance of the fluid is adversely affected.

Maintenance: To obtain maximum efficiency and fire resistance, these fluids must be examined periodically for alkalinity and viscosity.

Alkalinity helps indicate the additive content. Viscosity is directly related to water content. Thus, higher than normal viscosity means low water content. Only distilled or deionized water should be added for water make-up. If a lower than normal viscosity is obtained, excess water is present. This usually is caused by a leaky cooler.

Bibliography

This article is the fourth in a group on hydraulic fluid selection. Previous articles and issues of Machine Design in which they appear are:

1. "Emulsion-Type Hydraulic Fluids," by R. T. Holmes, Dec. 8, 1960
2. "Petroleum-Base Hydraulic Fluids," by R. L. Leslie, Aug. 3, 1961
3. "Synthetic Hydraulic Fluids," by R. E. Hatton, Oct. 26, 1961

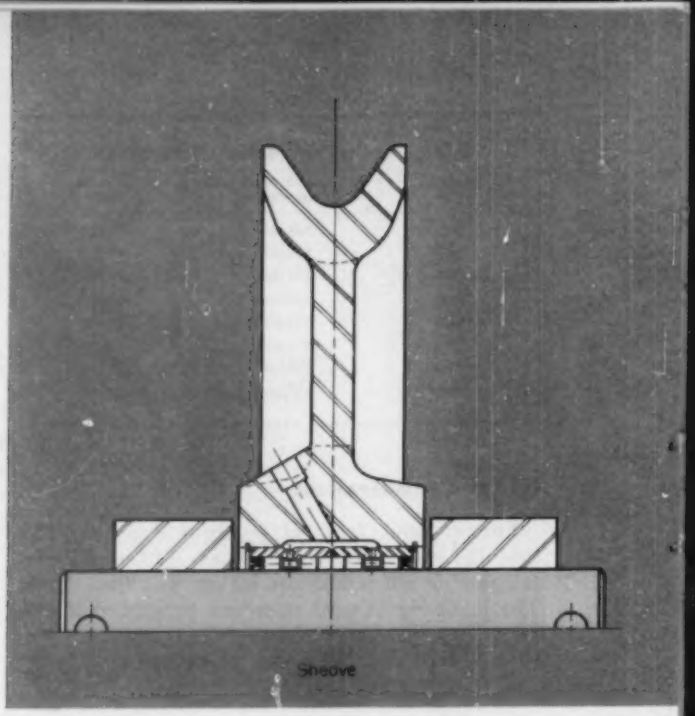


Fig. 1—Typical applications where a shaft replaces the inner bearing race.

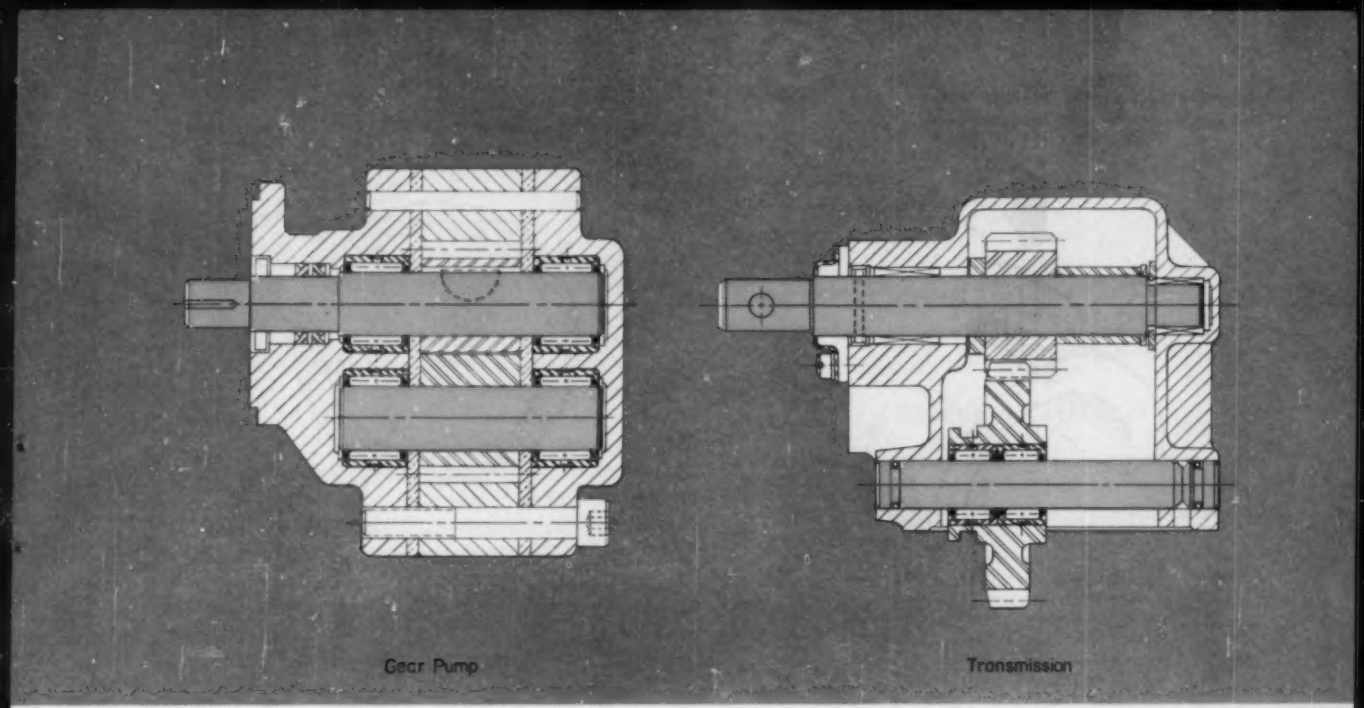
Simplicity,
economy
and compactness
can be gained
by designing a shaft to
serve also as a bearing race.
But,
proper choice of material
for these dual requirements
is critical.
Here's a general guide for selecting . . .

Materials for **Shafts with integral bearing races**

RICHARD J. SMITH
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Bearing Div.
McGill Mfg. Co. Inc.
Valparaiso, Ind.

THE best possible shaft material and heat treatment must be used to obtain optimum performance from needle and radial roller bearings without inner races. This is especially critical in cases of outer-race rotation where the shaft becomes the weakest member of the bearing assembly in fatigue. Sheave, gear-pump and transmission applications are typical cases, Fig. 1. Manufacturing costs as well as operating clearances can be reduced by omitting the inner bearing races.

When inner races are used, selection of shaft material is principally a matter of manufacturing



economy coupled with proper bending and tensile strength. In most cases, surface heat treatment of shafts is omitted. However, when the inner race is eliminated, the shaft then becomes an integral member of the bearing, and two factors must then be considered for best bearing performance: 1. Shaft material selection and heat treatment. 2. Shaft surface finish.

Materials and Heat Treatment

A number of satisfactory steel shaft materials can be utilized. They can be broken down into two groups: 1. Through-hardening material. 2. Case-hardening material.

To attain highest load-bearing capacity, premium bearing materials must be used.

SAE 52100: Where through or induction-hardening materials are employed, the material of highest quality and most predictable heat treatment is SAE 52100 steel, such as used by bearing manufacturers. This material may be induction zone-hardened or through-hardened in accordance with the dictates of the application. However, as shaft material in the through-hardened state, SAE 52100 steel has high core hardness which causes brittleness that may be objectionable. Zone or induction-hardening provides a tougher core and is usually more satisfactory for shaft applications.

SAE 4650 and 8650: These high-carbon steels are used when structural members are combined with bearing races. Here, the bearing material in use must have a double set of requirements: 1. It must be structurally strong to withstand bending stresses which do not affect a separable bearing race. 2. It must have resistance to fatigue, required by operation as an antifriction bearing.

SAE 4650 and SAE 8650 do not require carburization for induction hardening. However, the absence of excess carbides in the surface structure of the material after heat treatment reduces the fatigue life of the material correspondingly. Hardnesses in the range of Rc 60 should be maintained under all circumstances.

Particular applications are in automotive equipment where loads are heavy and predictable life is desired. They could be used in such applications as shafts, combination structural members of earthmoving equipment which also function as bearing components, and fatigue-resistant gears operating as bearing outer races.

SAE 4615 and 8620: SAE 4615 and 8620 steels are used with antifriction bearings more than any other single material because they give the best fatigue life. However, they are not generally usable as combination machine members and bearing structures since they would require the carburizing of rather complicated cross sections. These steels could be used in practically any industry, primarily as gear pump shafting where the carburizing heat treatment is simple.

SAE 1050 and 1150: Alternate materials such as SAE 1050 or 1150 steels may be used in the interests of economy, employing the induction or flame-hardening process. While these steels will induction harden satisfactorily to give the proper hardness

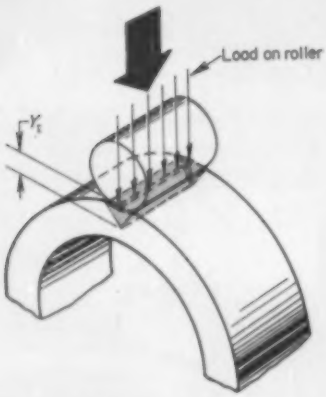


Fig. 2—Bearing rollers cause subsurface shear stresses in shaft. Y_I is the depth to the point of maximum subsurface shear stress.

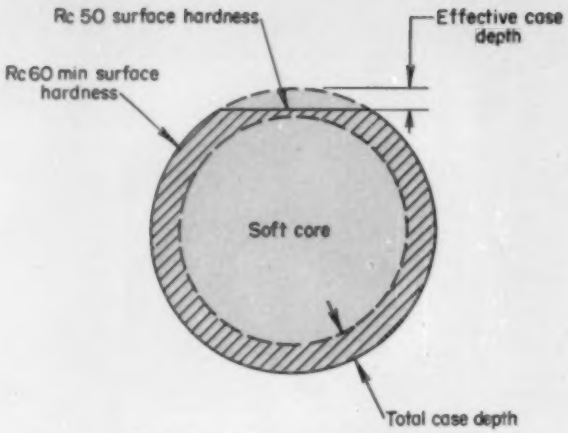


Fig. 3—Effective carburized case depth is determined by the removal of metal from a shaft diameter until a surface hardness of Rc 50 is obtained.

ranges, they will not offer the fatigue resistance of the higher carbon content steels.

SAE 1050 and 1150 steels are generally used in low-cost applications in farm equipment and appliances as gears, shafts, track rollers, and bearing links, acting as outer or inner-race members.

Case-Hardening: For case hardening, any number of materials can be employed, ranging from plain-carbon SAE 1010 to 1020 up through SAE 4615, 4620, 8615 and 8620. Shafts can be completely carburized and case hardened or zone hardened by masking or copper plating the areas desired left in a soft state. Again a minimum hardness of Rc 60 should be employed.

Through Hardening: For best heat-treatment quality, the hardening temperature in both the induction and through-hardening process must be held to close limits to avoid the formation of retained austenite. In water quenching of induction-hardened steels, cracking of shafts after treatment should be avoided by immediate tempering.

Carburizing Case Depth

Another major factor which is sometimes incorrectly specified or ignored by the bearing user is the establishment of proper carburizing case depths. Since determination of the case depth in carburized parts can affect both the unit cost of parts as well as the fatigue performance of bearing components, it is advantageous to have some method of calculating case depths.

The first consideration for case-depth calculation is determining the depth to the point of maximum subsurface shear stress. This is required since the carburizing case depth of shafts used with antifriction bearings is a direct function of the subsurface stress set up by the roller bearing in contact with the shaft, Fig. 2.

It has been determined empirically that the effective case depth should be a minimum of four times the depth to the point of maximum subsurface shear stress. Then the following equation can be used to determine the depth to the point of maximum subsurface shear stress for inner-race shafts:

$$Y_I = 0.000427 \sqrt{\frac{F_R}{ZL\left(\frac{1}{D_R} - \frac{1}{D_I}\right)}}$$

where Y_I = depth to point of maximum subsurface shear stress (inner race), in.; F_R = total radial load on bearing, lb; Z = number of rollers; L = effective roller length, in.; D_R = roller diameter, in.; D_I = inner race diameter, in.; D_O = outer race diameter, in.

The corollary equation for the outer race is

$$Y_O = 0.000427 \sqrt{\frac{F_R}{ZL\left(\frac{1}{D_R} + \frac{1}{D_I}\right)}}$$

where Y_O = depth to point of maximum subsurface shear stress (outer race), in.

This case depth is the depth after finish grinding. Depending upon diameter and cross section of the part in consideration, extra case depth must be added to take care of potential out-of-roundness due to heat treatment, machining, etc.

Effective case depth is defined as the depth at which a surface hardness of Rc 50 can be measured. Case depths are established as a function of the shaft diameter and the maximum load which can be applied to the shaft surface. As an example, an effective case depth of 0.040 in. for shaft diameters up to 2 in. is considered satisfactory. Effective case depth as noted here would mean that depth at which a

hardness of Rc 50 can be measured after removal of a 0.040-in. section of hardened surface, Fig. 3.

Shaft Surface Finish

A practical maximum surface finish for shafts being used as inner races is 25 microinches rms. Although rougher surface finishes can be employed, the user will run the risk of more erratic performance because of shaft wear-in and poorer dimensional accuracy of the mounted bearing. All bearings wear in, and the amount of wear-in depends directly upon the surface finish of the mating parts. The rougher the surface, the greater the wear-in, and the greater the resulting clearance. A shaft finish in the range of 15 microinches rms maximum is preferred, since a certain amount of shaft wear-in is avoided and built-in clearances are more nearly retained throughout the life of the assembled bearing.

In many cases the bearing manufacturer will employ a finer surface finish than 15 microinches rms. However, it would be imposing a hardship on most suppliers of shafts and other components associated with bearings to specify these finer shaft finishes as a requirement for bearing performance.

If too fine a shaft surface is employed, seizing and galling take place, which can lead to early fatigue failure. For this reason, shaft finishes less than 5 microinches rms are to be avoided unless specifically recommended by the bearing manufacturer.

Subsurface Shear Stress

It is often advantageous to know whether the maximum loading on a bearing component will exceed allowable values for subsurface shear. To evaluate these loads, use

$$S_o = 2645 \sqrt{\frac{F_R}{ZL}\left(\frac{1}{D_R} - \frac{1}{D_O}\right)}$$

where S_o = maximum subsurface shear stress (outer race), psi.

$$S_I = 2645 \sqrt{\frac{F_R}{ZL}\left(\frac{1}{D_R} + \frac{1}{D_I}\right)}$$

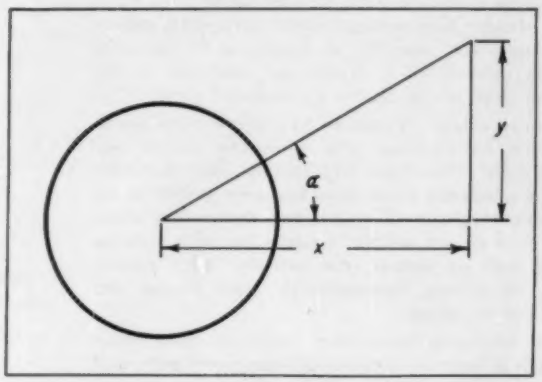
where S_I = maximum subsurface shear stress (inner race), psi.

Nominal shear stress figures for outer and inner race and rollers are 175,000 to 200,000 psi. Under extreme limits of bearing design, a maximum figure not exceeding 350,000 psi is sometimes employed. Shear stresses of 350,000 psi are applied in near-static applications where repetitive fatigue would not be a factor. These nominal figures are approximately 70 per cent of the actual compressive stress applied to the roller or race and will be fairly constant for all alloy steels suitable for bearing usage. The exact magnitude of allowable stresses for low-carbon steels and marginal bearing steels is not known at the present time.

Tips and Techniques

Dividing a Circle

One way to divide a circle into N parts is to construct the central angle subtended by one division. This can be done easily by using the values shown. These values are simply a ratio of the y and x components of the triagle, as shown in the illustration, for various values of N.



N	y/x	N	y/x	N	y/x	N	y/x
5	40/13	14	13/27	23	7/25	32	1/5
6	97/56	15	4/9	24	15/56	33	16/83
7	84/67	16	29/70	25	19/74	34	17/91
8	1/1	17	31/80	26	17/69	35	2/11
9	73/87	18	4/11	27	23/97	36	3/17
10	8/11	19	23/67	28	21/92	37	6/35
11	9/14	20	13/40	29	22/100	38	1/6
12	56/97	21	29/94	30	17/80	30	13/80
13	21/40	22	27/92	31	15/73	40	13/82

To construct an angle between 45 and 90 deg, simply use the component of the angle. This method is accurate to within 1 min of arc, except when the angle is 14, 24, 31, or 36 deg, where the error is less than 2.25 min of arc. — SIDNEY KRAVITZ, *Dover, N. J.*

Do you have a helpful tip or technique for our other readers? You'll receive ten dollars or more for each published contribution. Send a short description plus drawings, tables, or photos to: Tips and Techniques Editor, MACHINE DESIGN, *Penton Bldg., Cleveland 13, O.*

Critical Speed of Shafts

In the October 12, 1961, issue, Page 205, the upper scale for diameter, d, should range from 1 through 6 rather than 10 through 60.

A proposed 25-deg pressure-angle system for **Powder-Metal Gears**

Because of minute voids, powder-metal parts have lower density than wrought-metal parts—and generally, less shear strength. A density of 95 per cent (of the solid form) is considered maximum in the present state of the art for sintered-iron parts.

Density values, as applied to powder-metal parts, must not be confused with equivalent weight per cubic inch. So-called high-density iron materials can be produced which have the same weight as an equivalent volume of cold-drawn steel. But when a portion of the weight is made up of a heavier metal such as copper, the material lacks density (and, of course, homogeneity), even though the weight is the same.

Dry lubricants and other additives also cause strength differences between powder-metal parts and those made from solid metal. Although materials such as molybdenum disulfide and graphite improve wear life of powder-metal parts, this advantage is gained by compromising strength properties.

In gears particularly, the strength problems of powder-metal parts are further augmented by inherent weaknesses of standard tooth-form systems which are based on practical considerations of gear-cutting equipment.

This article offers a solution to these problems—a tooth profile based on principles used in the design of highly stressed gears.

Typical Physical Properties of Sintered Iron

Type*	Density† (gm/cu cm)	Tensile Strength§ (1000 psi)	Yield Strength§ (1000 psi)	Elongation (per cent in 2 in.)
1	6.9 to 7.3	28 to 35	20 to 24	7 to 10
2	7.4 (min)	85 to 89	52 to 56	4 to 8
3	7.4 (min)	45 to 49	29 to 31	14 to 25
4	6.8 to 7.3	75 to 95 65 to 75 50 to 62	....	0 ½ 1
5	7.4 (min)	65 to 70 62 to 65 52 to 58	....	½ to 1½ 2 to 3¼ 3½ to 7
6	7.4 (min)	190 to 200	190 to 200	0 to 1
7	7.4 (min)	160 to 170 132 to 138 90 to 100	157 to 165 110 to 120 75 to 85	1 1 to 2 2 to 4

*Type numbers are arbitrary designations.

†Density of theoretical solid is 7.97 gm/cu cm.

§Where more than one strength is shown, values represent typical strengths after different tempering operations.

Data courtesy Globe Industries Inc., Supermet Div., Dayton, Ohio.

SINTERED-METAL gears are not as strong as those made from solid metals having the same analysis and tooth geometry. Shouldn't standard tooth profiles then be examined and perhaps modified to raise load-carrying capacities of powder-metal gears? Since standard tooth forms are based partly on requirements of gear-cutting tools, it follows that these limitations do not apply to sintered-metal gears.

Departure from standard profiles may not be appealing. But at best, standards are compromises between the optimum solution to a problem and economic considerations. Generally, sintered-metal gears are used in high-volume, special-purpose applications. Tailoring the tooth geometry to suit both the process and the application appears to be a logical and effective design direction. Load-carrying capacity of gear teeth can be significantly increased. The tooth form discussed here follows some of the design principles used for highly stressed gears, where pressure angles of 25 deg and higher are common.

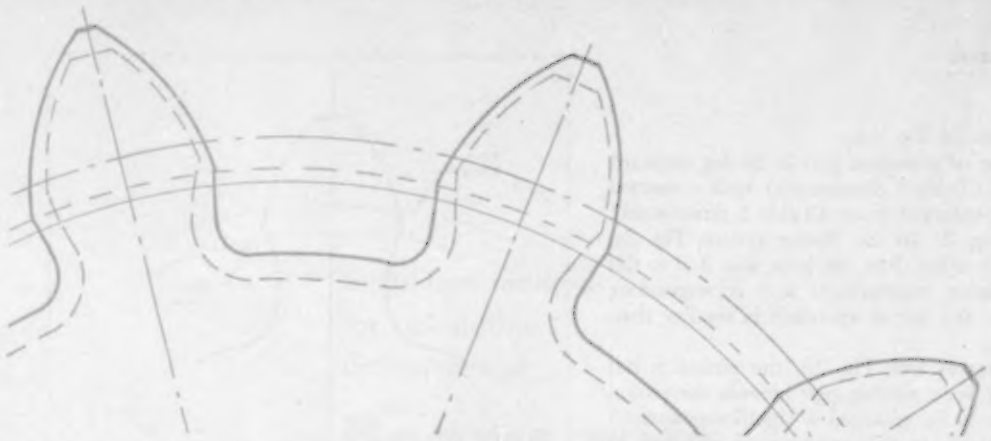
Standard Enlarged Pinions

To reduce objectionable undercut in standard pinion-tooth profiles and to increase involute action, ASA and AGMA standards include dimensions for enlarged pinions and mating gears, Table 1. In the 20-deg fine-pitch system shown, pinions having 7 to 17 teeth are enlarged and the 7-tooth pinion requires a mating gear with a minimum of 42 teeth. Under ideal conditions, this combination results in a contact ratio of slightly over 1.2.

However, since these standards are also based on tooling considerations for cut teeth, all undercut is not eliminated. Although pinions enlarged to this standard meet the requirements of most cut gears, they often do not provide a sufficient margin of safety for powder-metal gears of the same size.

Proposed Enlarged Pinions

Dimensions for 25-deg pressure-angle pinion based on the same principle as Table 1 (avoiding all objectionable undercut and providing full involute action to the working depth of the teeth), are shown in Table 2. Here, only five pinions need to be enlarged to avoid undercut, and the minimum number of teeth in a gear mating with a 7-tooth pinion



is only 16. The nominal contact ratio of this combination is 1.213.

Pinions specified according to standard proportions (not enlarged in accordance with Table 1) are not only weak, but they also pose serious tooling problems when the parts are made of sintered metals. For example, a typical 10-tooth pinion made to standard proportions, Fig. 1*a*, is severely undercut—a most undesirable condition for sintered parts. Also, this pinion does not yield a large enough contact ratio to assure uniform load transmission.

A similar pinion, made in accordance with Table 2, is shown in Fig. 1*b*. For all practical purposes, it is a standard 10-tooth, 25-deg pressure-angle pinion. Its enlargement is only 0.00036 in., which is within allowable manufacturing tolerances. This pinion has greater beam strength—almost 70 per cent more load-carrying capacity—and a longer active profile



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Table 1—20-deg Involute Spur Gears
Dimensions* for Enlarged Pinions and Mating Gears

Enlarged Pinion			Reduced Mating Gear at Std Ctr Distance			
Number of Teeth	Outside Diam	Tooth Thickness at Std Pitch Diam	Minimum Number of Teeth	OD of Smallest Mating Gear	Tooth Thickness at Std Pitch Diam	Decrease from Std OD
7	9.8288	2.0907	42	42.8188	1.1409	1.1812
8	10.8738	1.9561	39	39.9358	1.1835	1.0642
9	11.8380	1.9155	36	37.0528	1.2261	0.9472
10	12.8302	1.8730	33	34.1698	1.2686	0.8302
11	13.7132	1.8304	30	31.2868	1.3112	0.7132
12	14.5963	1.7878	27	28.4037	1.3538	0.5963
13	15.4793	1.7452	25	26.5207	1.3964	0.4793
14	16.3623	1.7027	23	24.6377	1.4389	0.3623
15	17.2454	1.6601	21	22.7547	1.4815	0.2453
16	18.1284	1.6175	19	20.8716	1.5241	0.1284
17	19.0114	1.5749	18	19.9886	1.5667	0.0114

*Dimensions are in inches for 1 D.P. For other pitches, divide tabular values by the D.P.
Data from ASA B6G.7-1956 and AGMA 207.04, "20-Degree Involute Fine-Pitch System."

Table 2—25-deg Involute Spur Gears
Dimensions* for Enlarged Pinions and Mating Gears

Enlarged Pinion			Reduced Mating Gear at Std Ctr Distance			
Number of Teeth	Outside Diam	Tooth Thickness at Std Pitch Diam	Minimum Number of Teeth	Tooth Thickness at Std Pitch Diam	Decrease from Std OD	Contact Ratio
7	9.6600	1.9204	18	1.2212	0.7498	1.213
8	10.5712	1.8372	15	1.3044	0.5712	1.264
9	11.3926	1.7539	14	1.3877	0.3926	1.286
10	12.2140	1.6706	13	1.4710	0.2140	1.300
11	13.0354	1.5873	12	1.5543	0.0354	1.306

*Dimensions are in inches for 1 D.P. For other pitches, divide tabular values by the D.P.

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than the pinion in Fig. 1*a*.

A comparison of a meshed pair of 20-deg standard enlarged gears (Table 1 dimensions) with a meshed pair of 25-deg enlarged gears (Table 2 dimensions) is shown in Fig. 2. In the 20-deg system, Fig. 2*a*, the pinion is stronger than the gear, and due to the appreciable pinion enlargement and corresponding gear reduction, the arc of approach is smaller than arc of recession.

In the 25-deg system, Fig. 2*b*, the pinion is not quite as strong as its mating gear because the pinion does not have to be enlarged a significant amount to avoid undercut. In this combination, the arcs of approach and recession are almost equal—an ideal combination for a reversing drive in which the gear and pinion alternate as drivers.

However, if the pinion were always the driver, it would be desirable to over-enlarge the pinion and reduce the gear a corresponding amount. Since the pinion has an adequate top-land, it would be a simple matter to obtain a long arc of recess by this means.

Gears having predominantly long arcs of recess wear better than those which do not. The 25-deg pressure-angle system lends itself better than systems of lower pressure angles to obtaining this desirable condition.

It is true that increasing the pressure angle from 20 to 25 deg increases bearing pressure. However, since this pressure increases inversely as the cosine of the angle, the difference is only a matter of 4 per cent.

Another design consideration is that of increased backlash in higher pressure-angle systems for a given center-distance variation. (Backlash is proportional to the tangent of the angle.) However, for most applications of sintered-metal gears, this factor has only a minor effect on manufacturing tolerances.

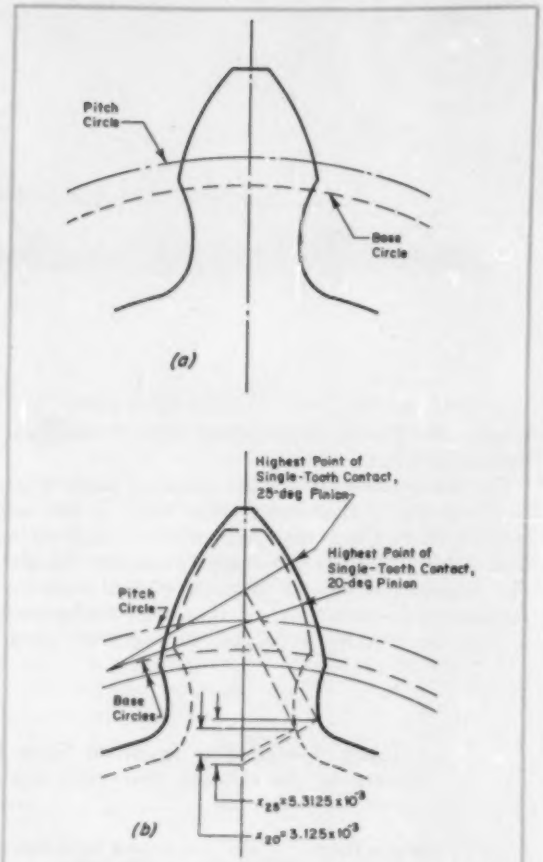


Fig. 1—Typical tooth forms for 10-tooth, 96 diametral-pitch pinions. Standard enlarged form (20-deg pressure angle), *a*, has severe undercut; proposed enlarged form (25-deg), *b*, is stronger. Comparison of the two forms (dashed line is 20-deg profile) is shown in *b*. Form factor *Y* in the well-known Lewis equation for beam strength is proportional to dimension *x*.

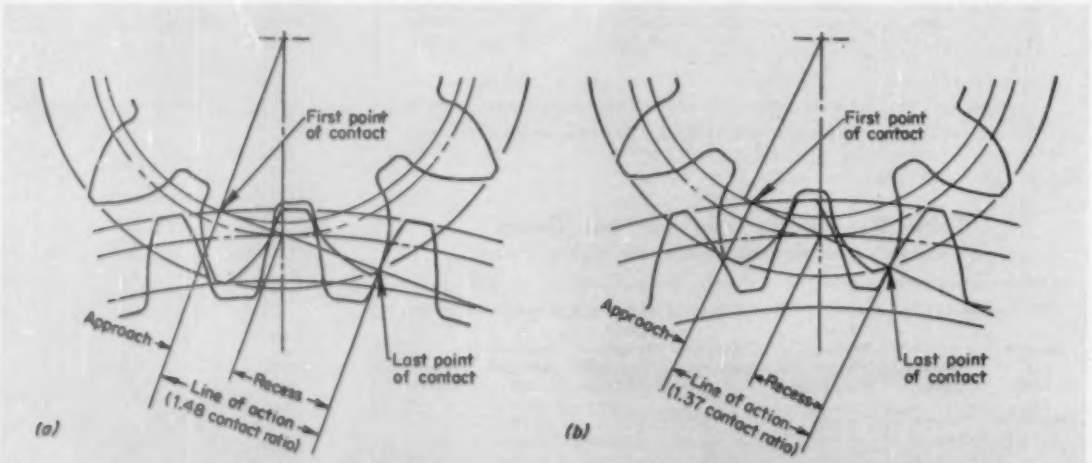


Fig. 2—Meshed enlarged pinions and reduced gears at standard center distances. Standard enlarged components (20-deg pressure angle), *a*, provide long recess action; proposed enlarged pair (25-deg), *b*, show nearly equal approach and recess action for degree of enlargement used.

Simplified methods for calculating deflections of

Beams with Nonuniform Stiffness

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STIFFNESS of structures cannot always be represented by simple algebraic expressions. In such cases, numerical integration is a convenient method of solving beam deflections. Structures are divided into small elements of assumed constant stiffnesses, and the incremental deflections of each element are added to get the total deflection. This article presents two numerical methods for calculating deflection of cantilever beams with nonuniform stiffnesses.

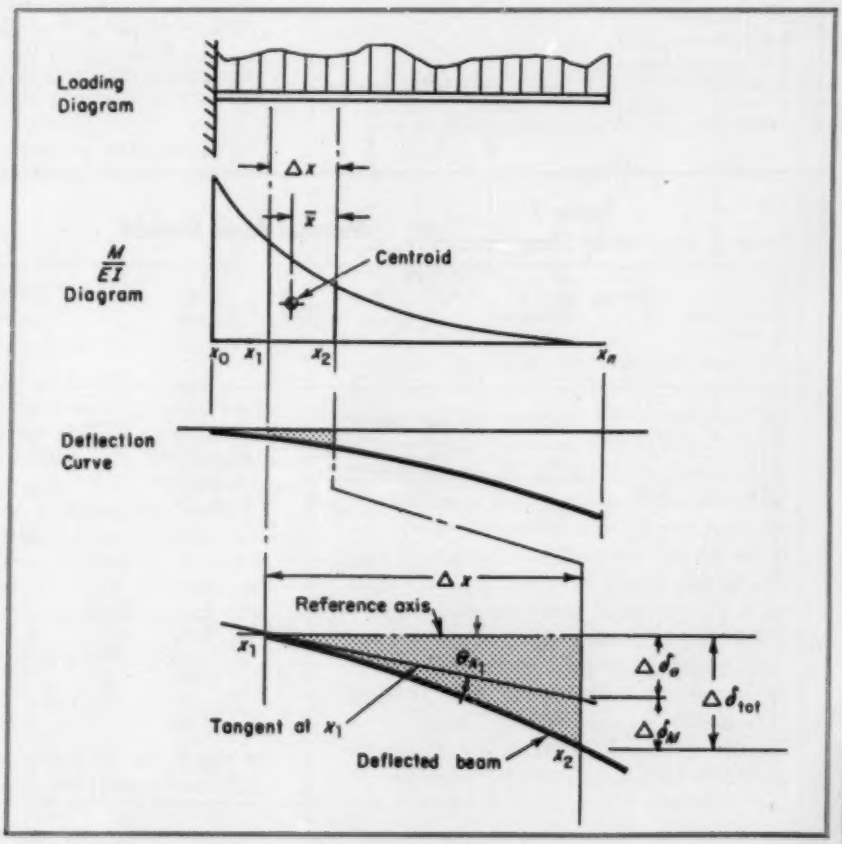


Fig. 1 — Diagrams for modified moment-area method.

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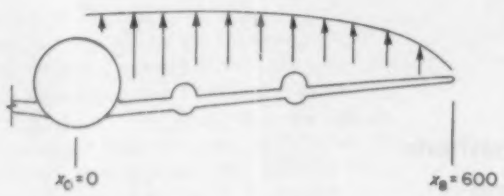


Fig. 2—Cantilever-beam airplane wing.

Nomenclature

- A = Cross-sectional area of member (sq in.)
- a = Length of shear panel (in.)
- b = Width of shear panel (in.)
- E = Tension modulus of elasticity (psi)
- G = Shear modulus of elasticity (psi)
- I = Moment of inertia (in.^{4})
- K = Spring constant (lb/in.)
- M = Bending moment (in.-lb)
- m = Secondary bending moment (in.-lb)
- P = Axial load due to actual load (lb)
- p = Axial load due to unit load (lb)
- q_0 = Shear flow due to actual load (lb/in.)
- q_1 = Shear flow due to unit load (lb/in.)
- t = Thickness of beam web (in.)
- x = Member length or station (in.)
- $\bar{x}$ = Distance from end of element to centroid of element in M/EI diagram (in.)
- Δ = Increment
- δ = Deflection (in.)
- θ = Angle of beam slope

Any integral form may be expressed as the summation of a series of small elements. Accuracy of the process is a function of the size of increments chosen. Essentially, the summation process changes a deflection calculation from a calculus problem to an algebra problem, which is generally easier to solve.

Probably the most familiar method of calculating beam delections is the double-integration method.[1] Two other procedures, discussed here, are the moment area method and the energy method.

Moment-Area Method

This modified moment-area method is particularly useful for calculating airplane wing deflections. The reference slope of the deflection curve is usually assumed to be zero at the wing centerline (for sym-

[1]References are tabulated at end of article.

Table 1
Work Sheet

Moment-Area Method

① Station from fixed end, x_i (in.)	② $\frac{M}{EI}$ $\left(\frac{1}{\text{in.} \times 10^6}\right)$	③ $\left(\frac{M}{EI}\right)_{avg}$ $\left(\frac{1}{\text{in.} \times 10^6}\right)$	④ Δx (in.)	⑤ $\Delta\theta = \frac{M}{EI}\Delta x$ ③④ (rad)	⑥ $\theta_x = \frac{\sum M}{EI}\Delta x$ or $\int_0^x$ ⑤ (rad)	⑦ $\Delta\delta_\theta = (\Delta x)(\theta_x)$ ④⑥ (in.)	⑧ $\bar{x}$ (in.)	⑨ $\Delta\delta_M = \bar{x}(\Delta\theta)$ ⑤⑧ (in.)	⑩ $\Delta\delta_{tot}$ ⑦⑨ (in.)	⑪ δ $\int_0^x$ ⑩ (in.)
$x_0 = 0$	240				0	—		0	0	0
		250	75	0.0187			37.0			
$x_1 = 75$	260				0.0187	0		0.69	0.69	0.69
		272	75	0.0204			37.0			
$x_2 = 150$	285				0.0391	1.40		0.76	2.16	2.85
		293	75	0.0220			37.3			
$x_3 = 225$	300				0.0611	2.93		0.82	3.75	6.60
		305	75	0.0228			37.3			
$x_4 = 300$	310				0.0839	4.59		0.85	5.44	12.04
		305	75	0.0228			37.7			
$x_5 = 375$	300				0.1067	6.29		0.86	7.15	19.19
		273	75	0.0204			38.8			
$x_6 = 450$	245				0.1271	8.00		0.79	8.79	27.98
		170	75	0.0127			43.0			
$x_7 = 525$	95				0.1398	9.55		0.55	10.10	38.08
		48	75	0.0036			50.0			
$x_8 = 600$	0				—	10.45		0.18	10.63	48.71

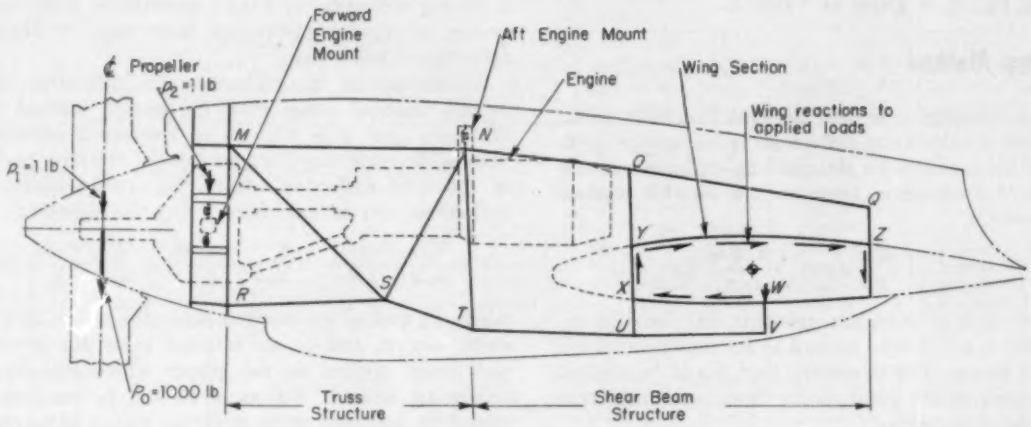


Fig. 3—Engine-support structure in airplane wing.

metrically loaded wings).

Determination of the deflection of a typical cantilever beam uses a load diagram, an $M/(EI)$ diagram, and a deflection curve, Fig. 1. The angle between tangents to the deflection curve at any two stations along the beam equals the area under the $M/(EI)$ diagram between ordinates at the two stations.

Vertical deflection of stations x_2 with respect to x_1 is

$$\Delta\delta = \theta(\Delta x) + \frac{M\bar{x}}{EI}(\Delta x) \qquad (1)$$

where θ, the slope of the beam at x_1, is

$$\theta = \sum_{0}^{x_1} \frac{M}{EI}(\Delta x)$$

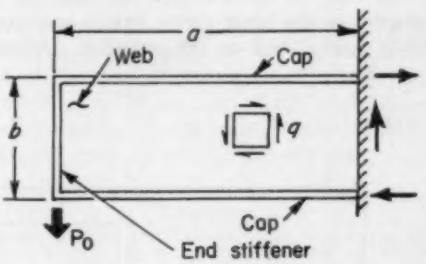
In Equation 1, $\theta(\Delta x)$ is the deflection between stations due to the slope of the beam, and the last term is the deflection between stations due to the bending moment between them. This last value is calculated by the moment-area method. Equation 1 gives the total deflection between two stations, and a progressive summation from the fixed end to the unsupported end gives the deflection at each station of the beam. The general form of this expression is

$$\Delta\delta = \left[\sum_{x_{i-1}}^{x_i} \frac{M}{EI}(\Delta x)\right]\Delta x + \frac{M}{EI}(\Delta x)\bar{x} \qquad (2)$$

and total deflection at any point on the beam is the sum of the incremental deflection from the fixed end to the point.

A numerical tabulation, using a modified moment

Shear Flow



Because shear-flow calculations are used predominantly in the aircraft-structures field, the terminology and procedures are not as well known in other areas of structural work.

Shear flow, q (lb per in.), is the shearing force per unit length along the cross section of a shear web. Bending is assumed to be concentrated in the beam caps, which carry no shear, and the web is assumed to be in pure shear, with no bending.

In the above figure, $q = P_0/b$, where P_0 is the load at the bottom of the end stiffener (lb) and b is the height of the shear panel (in.). Thus, shear flow can be obtained before the web thickness is determined, but shear stress is, of course, a function of web thickness. Shear stress (psi) in the web equals q/t, where t is web thickness (in.).

area method to solve for deflections of a cantilever beam, Fig. 2, is given in Table 1.

Energy Method

The most general and perhaps the most useful method of calculating deflections is the energy method. The equation for determining deflection at any point of a cantilever beam with a variable moment of inertia is

$$\delta = \int \frac{Mm}{EI}\,dx = \sum \frac{Mm}{EI}\,\Delta x$$

where m is a secondary moment due (in this example) to a 1 lb load applied at the unsupported end of the beam. The secondary load would be applied, of course, to any point on the beam, and deflections calculated accordingly.

Table 2 shows the energy-method calculations for deflection of the cantilever beam of Fig. 2. Comparison of Tables 1 and 2 shows that calculation of the deflection of a single point on the beam (energy method) requires considerably less work than calculation of the entire deflection curve.

For structures with appreciable shear, bending, and axial deflections, the energy method of calculating deflections is usually superior to other methods. An aircraft engine-support structure, Fig. 3, represents a typical composite assembly with complex deflection characteristics.

Suppose that the deflection of the propeller shaft with respect to the wing elastic axis is required for a 1000-lb vertical load on the propeller. Deflections which must be considered are: 1. Engine deflection. 2. Spring deflection of engine mounts. 3. Axial deflection of truss members and beam caps. 4. Shear deflection of beam webs.

Calculation of the deflections for this structure by any method other than the energy method is laborious, and it is difficult to keep such calculations sufficiently organized to prevent omitting parts of the total deflection. With the energy method, deflections can be calculated using the equation[2]

$$\delta = \sum \frac{P_0 p_1 L}{AE} + \sum \frac{q_0 q_1 ab}{Gt} + \sum \frac{P_0 p_1}{K} \quad (3)$$

where P_0 and q_0 are internal loads due to the actual loads, and p_1 and q_1 are internal loads due to the unit loads applied at the points where deflection values are desired. Values of P_0 and p_1 are determined by standard static methods; values of q_0 and q_1, by standard aircraft-structures methods, as described in *Shear Flow*. For shear panels that are not rectangular, average a and b dimensions are used.

With this expression set up in tabular form, deflection calculations become a mechanical arithmetic problem. The contribution of each element in the structure to the total deflection is clearly shown in the work sheet, Table 3, as an incremental deflection, making it simple to determine which element, if any, governs the over-all stiffness.

The work sheet shows calculations for two deflections: 1. That of the propeller with respect to the wing elastic axis, which must include deflections of all members. 2. That of the support structure at

Table 2
Work Sheet
Energy Method

① Station from fixed end, x_i (in.)	② $\frac{M}{EI}$ $\left(\frac{1}{\text{in.} \times 10^6}\right)$	③ m (in.-lb)	④ $\frac{Mm}{EI}$ ②③ (lb)	⑤ $\left(\frac{Mm}{EI}\right)_{avg}$ (lb)	⑥ Δx (in.)	⑦ $\Delta\delta$ ⑤⑥ (in.)
$x_0 = 0$	240	600	0.1440			
				0.1401	75	10.51
$x_1 = 75$	260	525	0.1362			
				0.1321	75	9.91
$x_2 = 150$	285	450	0.1280			
				0.1203	75	9.02
$x_3 = 225$	300	375	0.1125			
				0.1028	75	7.71
$x_4 = 300$	310	300	0.0930			
				0.0803	75	6.02
$x_5 = 375$	300	225	0.0675			
				0.0522	75	3.92
$x_6 = 450$	245	150	0.0368			
				0.0220	75	1.65
$x_7 = 525$	95	75	0.0071			
				0.0036	75	0.27
$x_8 = 600$	0	0	0			
					Total Deflection =	49.01

Table 3
Work Sheet

Propeller and Structure Deflections by Energy Method

Member	Stiffness Parameters							Load			Deflection (in.)	
	Length, L (in.)	Area, A (sq in.)	Tension Modulus, E (10^6 psi)	Shear Modulus, G (10^6 psi)	$\frac{L}{AE}$	$\frac{ab}{Gt}$	$\frac{1}{K}$	P_0 (lb) or q_0 (lb/in)	P_1 (lb) or q_1 (lb/in)	P_2 (lb) or q_2 (lb/in)	at propeller $P_0P_1[L/AE \text{ or } 1/K]$ or, $q_0q_1[ab/Gt]$	at forward mount $P_0P_2[L/AE \text{ or } 1/K]$ or, $q_0q_2[ab/Gt]$
Beam Caps and Truss Members												
MN	63.2	0.740	10.5	—	8.13	—	—	1601	1.601	1.132	0.0208	0.0148
MS	56.2	0.676	29.0	—	2.87	—	—	-2040	-2.040	1.445	0.0119	0.0085
RS	42.0	0.650	10.5	—	6.15	—	—	-133	-0.133	-0.094	0.0001	0.0001
SN	45.9	0.840	29.0	—	1.89	—	—	-794	-0.794	-0.562	0.0012	0.0008
ST	24.7	1.020	29.0	—	0.84	—	—	-2166	-2.166	-1.537	0.0040	0.0028
NT	47.9	0.530	29.0	—	3.11	—	—	-297	-0.297	-0.189	0.0003	0.0002
NO	44.2	0.850	29.0	—	1.80	—	—	+2592	2.592	1.998	0.0121	0.0093
OQ	65.2	0.780	29.0	—	2.88	—	—	+1600	1.600	1.289	0.0074	0.0059
TU	44.2	0.740	29.0	—	2.06	—	—	-2600	-2.600	-1.995	0.0139	0.0107
UV	35.2	1.930	29.0	—	0.66	—	—	-1600	-1.600	-1.286	0.0017	0.0014
Shear Webs	a	b	t									
NOUT	44.2	45.7	0.025	9.4	—	8600	—	27.7	0.0277	0.0264	0.0066	0.0063
OQYZ	65.2	14.5	0.040	9.4	—	2520	—	49.1	0.0491	0.0395	0.0061	0.0049
UVWX	35.2	6.4	0.050	10.4	—	434	—	91.0	0.0910	0.0730	0.0036	0.0029
Engine-Mount Springs	K											
	50,000						20	1412	1.412	—	0.0399	—
	15,000						67	-412	-0.412	—	0.0114	—
Engine-Stiffness for Prop Shaft Load												
	78,500						12.7	1000	1.0	—	0.0127	
							Total Deflection				0.1537	0.0686

the forward engine mount, which includes only truss and shear-beam deflections. Unit loads p_1 and p_2 are applied at each of the points where the deflection value is desired, and internal load distributions are separately calculated for each of the unit loads and for the 1000-lb applied load. (Calculations required to determine internal loads are not shown since they are not pertinent to the discussion.) Incremental deflections due to each element of the structure are then calculated by Equation 3.

Axial loads in the beam caps and shear stresses in the webs are not constant between the points shown in Fig. 3. However, for simplification of this example, average loads in these members are used. If more accurate deflection values are required, elements which have varying loads may be broken down into smaller parts.

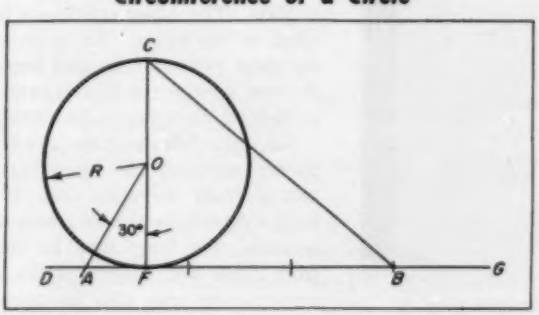
Table 3 shows that, for this example, the largest contribution to the deflection of the propeller shaft is that of the forward engine mount, which accounts for 0.0399 in. or 26 per cent of the total delflection. Of the remaining structure, truss member *MN* contributes the most deflection, 13.5 per cent.

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1. R. Bruce Hopkins—"Stepped Shafts and Nonuniform Beams," MACHINE DESIGN, Vol. 33, No. 14, July 6, 1961, pp. 159-164.
2. David J. Peery—*Aircraft Structures*, McGraw Hill Book Co., New York, N. Y., 1950, p. 440.

Tips and Techniques

Circumference of a Circle



The following method may be used to find the circumference of a circle quickly.

1. Draw line *DG* tangent to the circle.
2. Draw *OA*, at 30 deg from *OF*, to intersect *DG* at *A*.
3. Mark off $AB = 3R$. Circumference of the circle $= 2\,BC$.

—FRANK MURRAY, *Chicago, Ill.*

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Lighting with Electroluminescent Lamps

For compact numerical displays

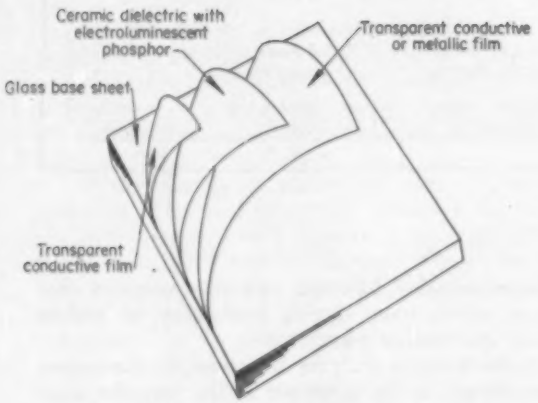


Fig. 1—Basic electroluminescent lamp.

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DISPLAY devices which use electroluminescence have a number of advantages. They combine low catastrophic failure rate with low power requirement, wide viewing angles, inherent low cost, and are nearly the ultimate from the standpoint of small size. By combining electroluminescent lamps (or neon glow lamps) and photoconductive cells, matrices may be made on a small piece of glass to perform complex switching functions. Self holding, or memory, features may be incorporated. These devices may be driven from conventional circuits.

The occurrence of luminescence requires the absorption, excitation, and emission of radiant energy. It is, therefore, convenient to classify the various types of luminescence by the means required for excitation. One of four types thus classified is electroluminescence. It occurs where, on excitation by an electric field, nonthermal radiation, which is characteristic of the material, is generated.

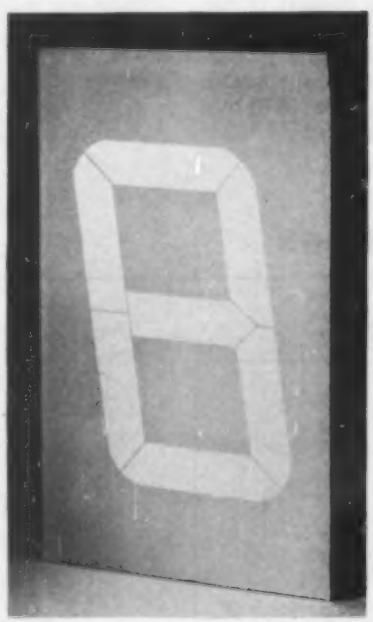


Fig. 2—Lamp for numerals 0 to 9.

Electroluminescent Devices

Numerical Displays: Elements of a simple "EL" lamp are shown in Fig. 1. In this case, the substrate upon which the lamp is constructed, is glass. The other strata are identified in the figure. An alternating electrical potential applied between the two conductive films causes the embedded phosphor to luminesce.

Since the first electrode is of transparent material, the lamp may be viewed from the glass side. If the final electrode is also of transparent material, the lamp may be viewed from either side. Lamps of this basic construction may also be made on

Circle 23-12 on Page 19 for extra copy.

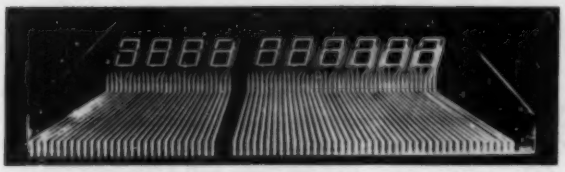


Fig. 3—Multinumeric of ten digits, ¼ in. high

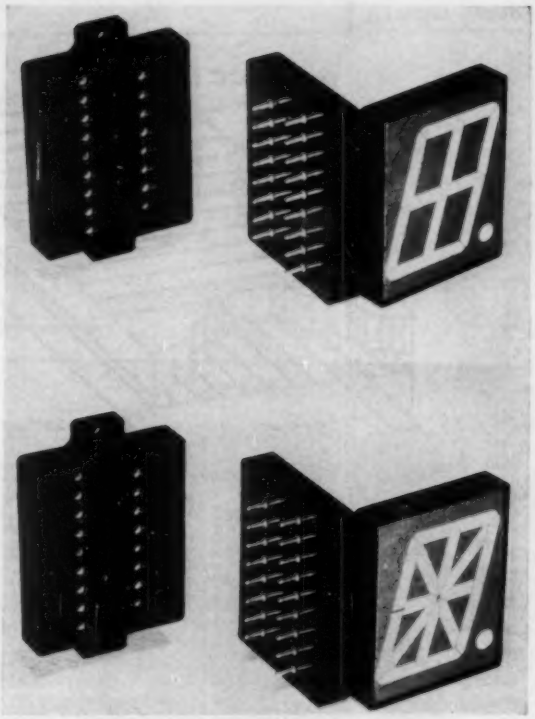


Fig. 4—Typical electroluminescent displays: Numeric (above) and alpha-numeric (below).

a metal substrate. There are almost no restrictions on size, shape, or contour.

A simple variation from this basic construction results in a readout device, Fig. 2. Here, an electrode on one side of the phosphor-dielectric is broken up into seven segments, and patterned to form the figure "8." By applying an AC potential between the proper segments and the common electrode on the opposite side of the electroluminescent material, the digits "0" through "9" may be displayed. This device has been called a "numeric."

Fig. 3 shows a multi-numeric with ten digits on a single substrate. Each digit is ¼ in. high. Connections are made by a printed-board type connector to the individual numeric segments.

With a somewhat more complex arrangement of segments, a device called an alpha-numeric may be made to display all the digits, a decimal point, and all twenty-six letters of the alphabet.

Typical devices in Fig. 4 have a character height of 1½ in. A matching socket permits plug-in convenience, and is especially attractive for applications such as status boards requiring a large number of letters or numerals.

There are a variety of such digital display devices commercially available. Sizes range from ¼ to 8 in. high. Various means of connections are available, such as printed board connectors, pigtail leads, and pins which may be soldered to directly.

EL readout devices are extremely attractive from the standpoint of size, since their size can be virtually the dimensions of the substrate upon which the device has been constructed. Being flat and having little depth, they are easily read over wide viewing angles. In many cases, contrast in ambient light is improved by applying a thin film of lacquer containing a dye on the viewing surface. Spectral reflections are minimized, while a large percentage of the radiated light is transmitted to the viewer.

In EL lamps, brightness is a function of both the applied AC voltage and its frequency. The current-power characteristic, Fig. 5, is essentially that of a lossy capacitor, similar to the equivalent circuit shown. Current and power shown are for 1 sq in. of illuminated area.

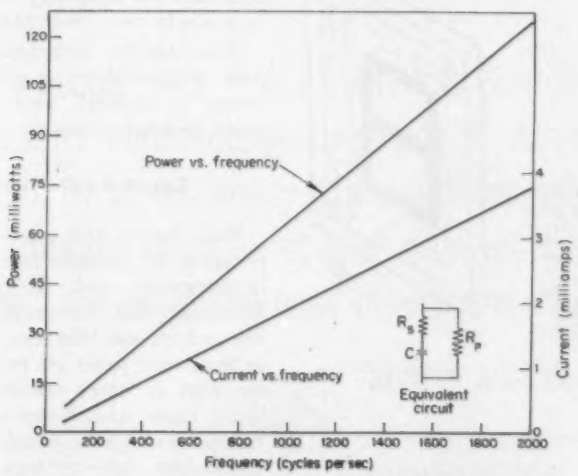


Fig. 5—Electrical characteristics of an electroluminescent lamp.

Electroluminescent Crossed Grid: Since most EL displays are made by graphic arts techniques, the electrodes of a given display may take nearly any configuration. It is a simple matter to produce sets of electrodes consisting of long narrow conductors at right angles to each other as indicated by Fig. 6. A phosphor dielectric is sandwiched between the two sets of electrodes. One set, of course, must be transparent.

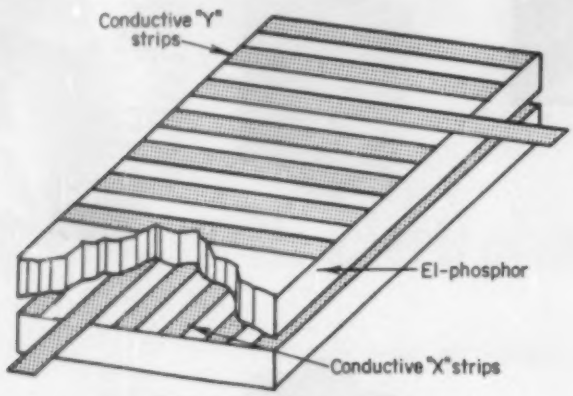


Fig. 6—Electroluminescent cross-grid assembly.

The intersection of a pair of electrodes (one on each side of the EL material) forms an electroluminescent cell. Therefore, it is possible to excite any cell in the matrix by addressing the proper co-ordinate conductors. By virtue of its basic construction, some light is also emitted along the entire length of the two conductors energized.

In this type panel, the contrast ratio between the intersection and the line may be from 4 to 16, depending upon the type of EL phosphor used. By proper application of voltage, this contrast ratio may be increased. Matrices of this type are commercially available with resolutions from 4 to 50 lines to the in. in panels up to 8 in. square.

Graphic art techniques are sufficiently accurate to allow individual panels to be aligned side by side to form a large continuous display. Computations made by a digital computer are in ideal form for the selection of lines and the graphic display of calculations on an EL matrix such as this.

Switching Techniques

Switching of numerics or alphanumerics may be accomplished by mechanical, electromechanical, electronic, or by electro-optical means.

In any case, since the display is segmented, some type of matrix is required to translate from the decimal (or binary) system to light the particular segments to form characters. Rotary switches or relays or a diode matrix and an electronic switch may be used. Although these well known techniques may have advantages in certain applications, in general they require a large number of cumbersome circuit components.

These observations prompted development of electro-optical switching techniques using EL or neon glow lamps and photoconductive, PC, gap cell matrices to perform certain translation and switching operations.

An example of an EL-PC switching matrix is shown in Fig. 7. Here ten EL bar lamps, a light mask properly coded, and an array of photoconductor gap cells provide a matrix for switching a seven segment numeric.

If voltage is applied to bar lamp No. 1, light will pass through the holes in the mask B directly in front. The proper PC gap cells are exposed, and current will flow from the ac source to the proper segments of the numeric to display the digit number "1." Each bar lamp, when lighted, will illuminate its own particular set of gap cells, to light the required numeric segments for each of the ten digits.

Since, in this example, EL bar lamps are used, ac voltage is required for excitation. The power required for lighting the bar lamps is a matter of microwatts. In situations where it is more convenient to drive the translator from dc voltages, each bar lamp may be replaced by a single neon glow lamp.

With similar techniques, other code translations are possible — binary to decimal, binary to numeric, decimal to binary.

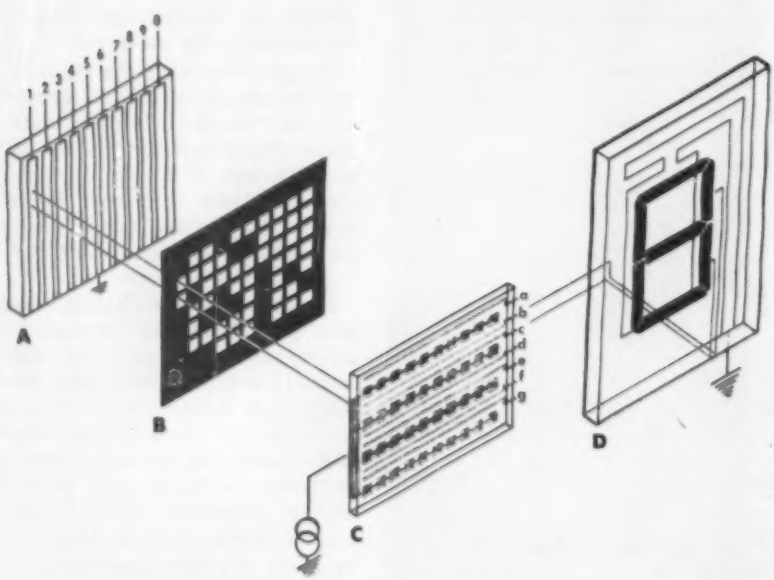
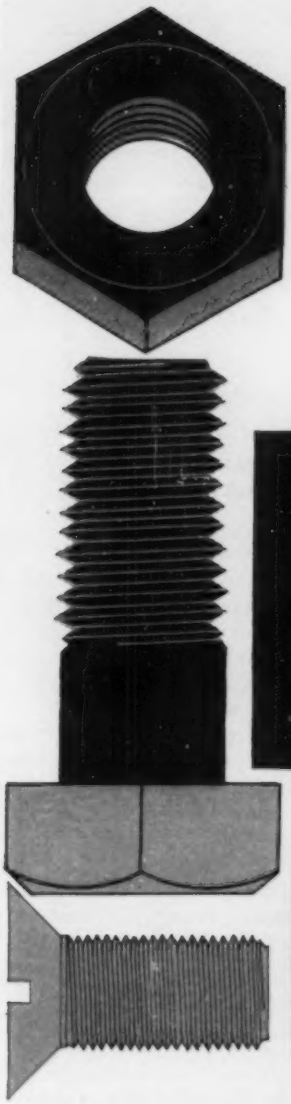


Fig. 7—Electroluminescent-photoelectric decimal-to-numeric switching assembly.

Circuit Applications

Well known and established applications of photoconductivity and luminescence, such as photocells, Electrofax, and Xerography, Vidicon pickup, and television reproducer and radar tubes are being joined by novel, far more sophisticated devices. Light and X-ray amplifiers, information storage panels, and optoelectronic computer logic elements are presently objectives of research



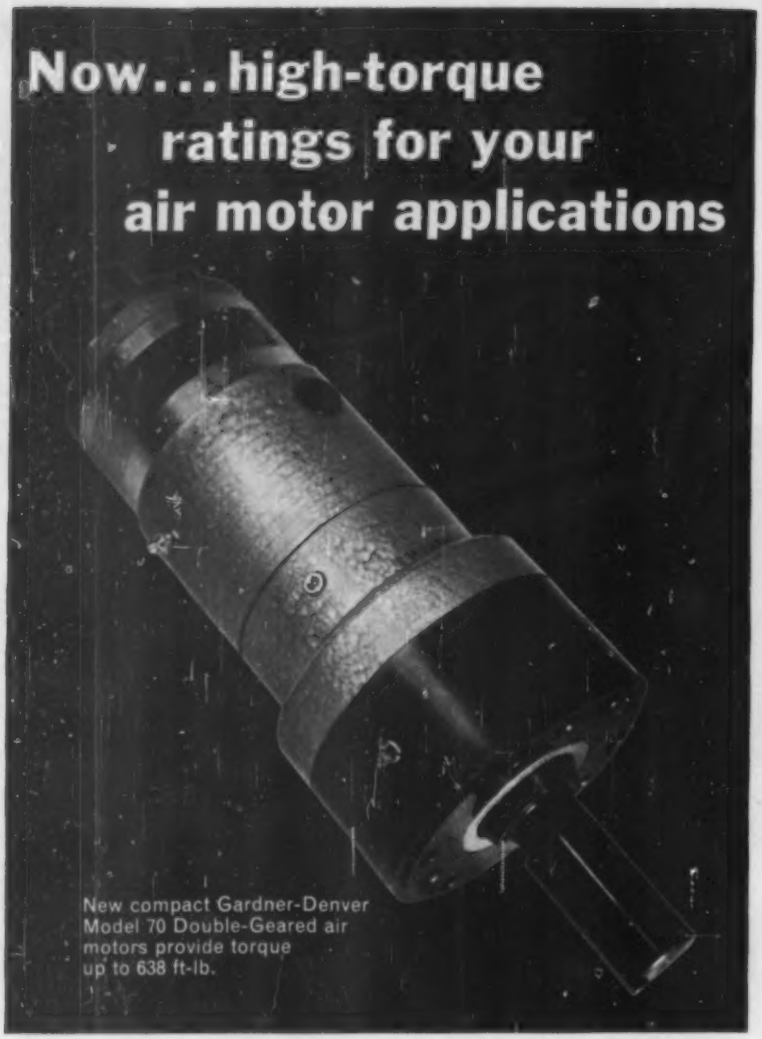
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studies in many laboratories. They are examples of the trend to integrate different electronically active solids into new compact components and devices.

WESCON Paper No. 5/3, "A New Approach to Digital Display Using Electroluminescence," presented at the 1961 Western Electronic Show and Convention, San Francisco, August, 1961, 7 pp.

bearings

Counterrotating Journal Bearings

O. Pinkus, Technical Research Group Inc., Syosset, N. Y.

A theoretical derivation showing that whenever the center of curvature of a bearing does not coincide with its center of rotation, synchronous counterrotation will produce a load capacity.

Test results are given for a number of bearing designs that operated successfully under synchronous counterrotation with load capacities beyond 1500 psi. The only bearing that scored under counterrotation was a perfectly circular ungrooved bearing, as predicted by theory.

ASME Paper No. 61-LUB-9, "Counterrotating Journal Bearings," presented at the ASLE-ASME Lubrication Conference, Chicago, October, 1961, 9 pp.

The Magnetohydrodynamic Slider Bearing

William T. Snyder, associate professor of engineering, State University of New York, Long Island Center, Oyster Bay, N. Y.

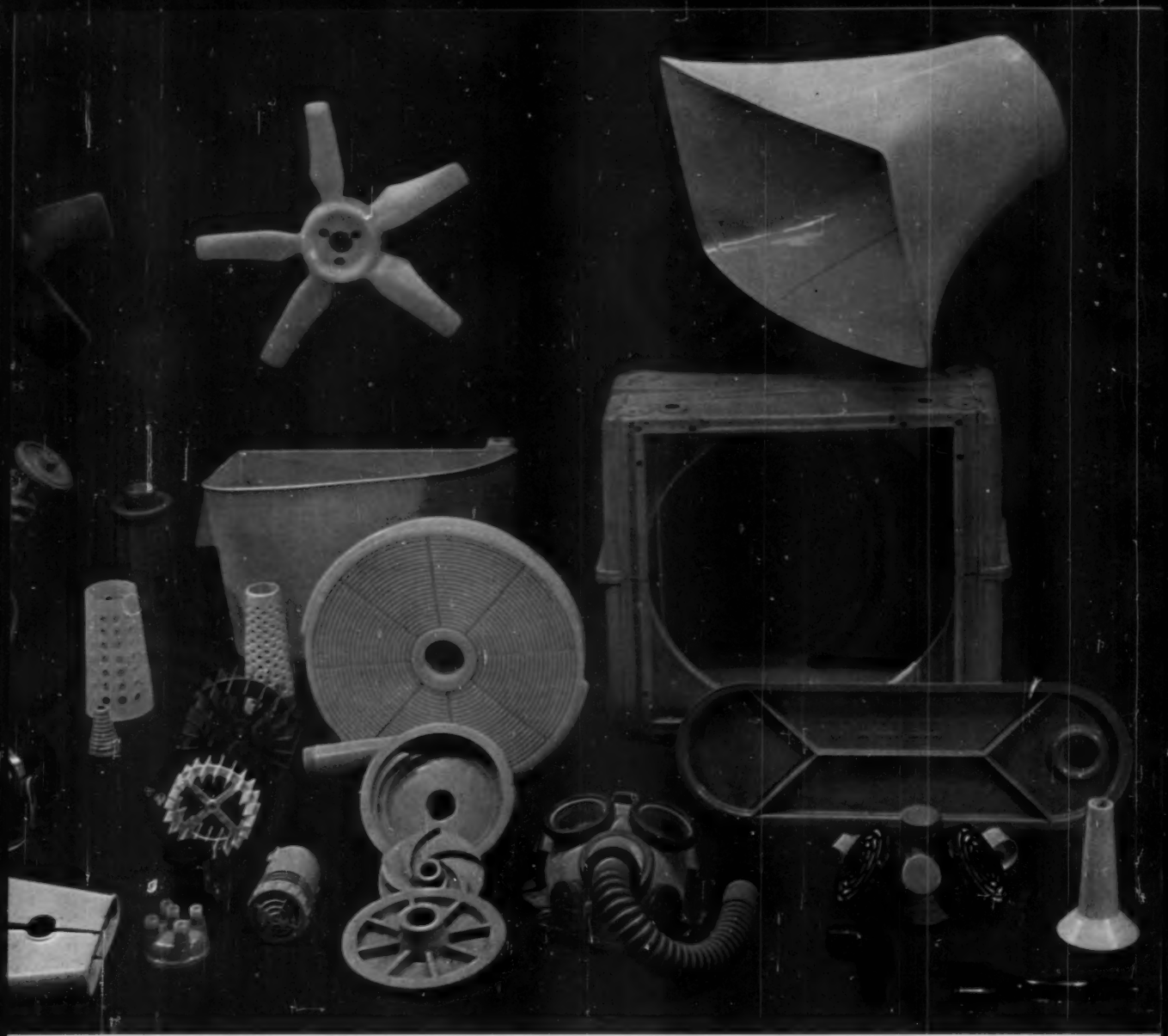
Analysis of the slider bearing using an electrically conducting lubricant, such as a liquid metal, in the presence of a magnetic field.

The solution permits the calculation of the load-carrying capacity of the bearing. A comparison is made with the classical slider bearing solution. It is shown that the load capacity of the bearing depends on the electromagnetic boundary conditions entering through the conductivity of the bearing surfaces.

Numerical data are presented for nonconducting surfaces with the emphasis on a comparison between the classical bearing and the mag-

Circle 309 on Page 19

Circle 310 on Page 19→



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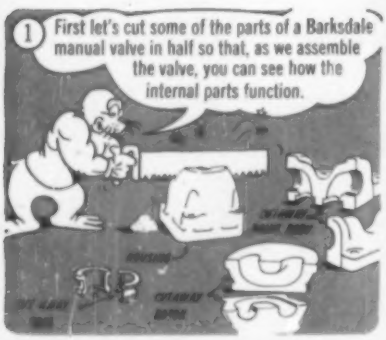
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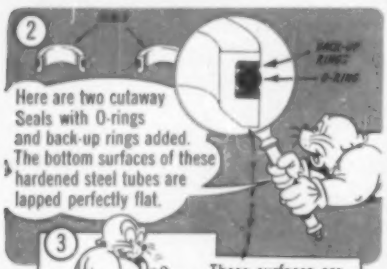
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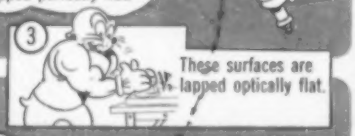
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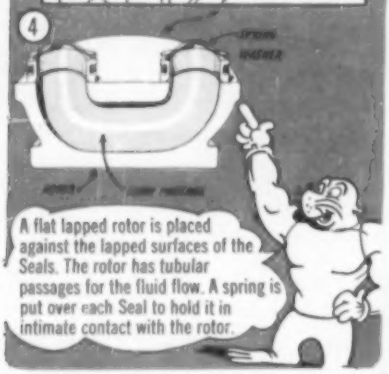
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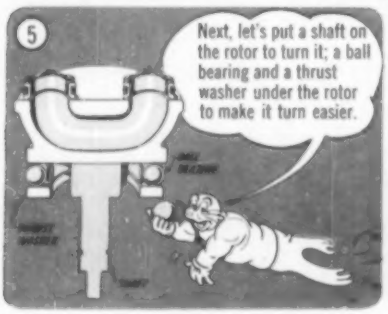


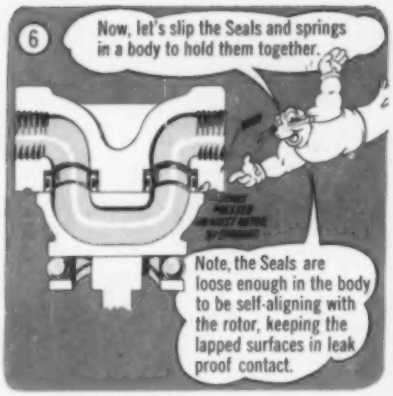


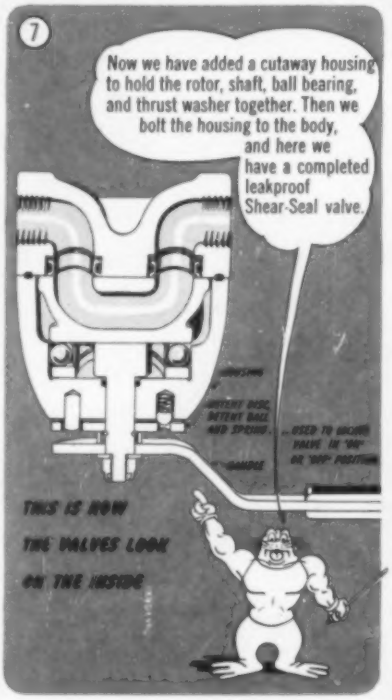


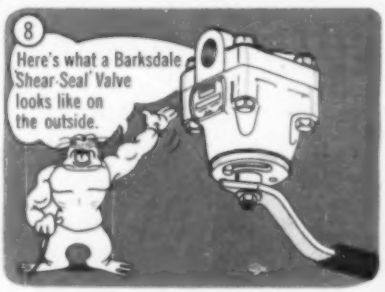


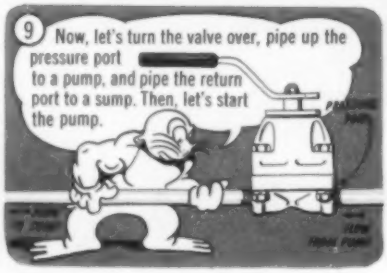


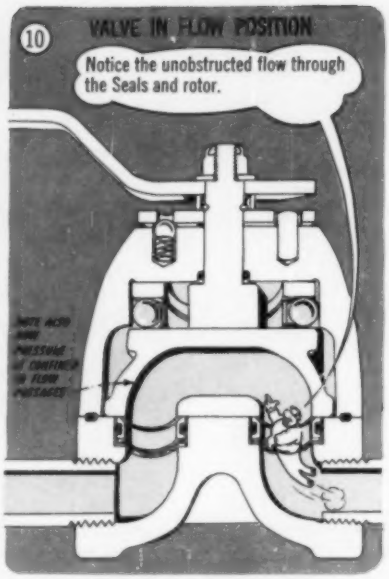


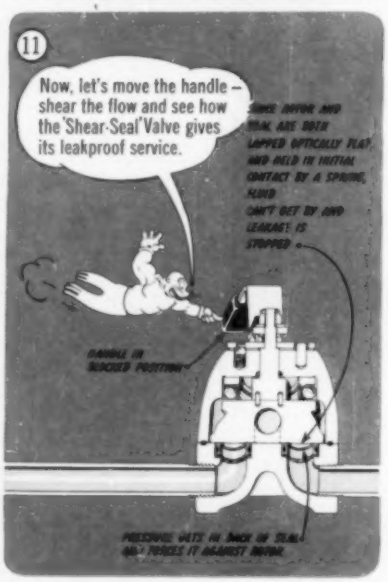


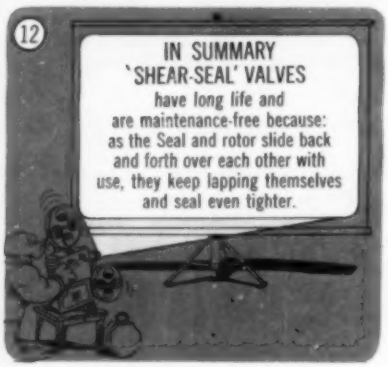












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netohydrodynamic bearing characteristics. It is shown that a significant increase in load capacity is possible with liquid metal lubricants in the presence of a magnetic field.

ASME Paper No. 61-LUB-10, "The Magnetohydrodynamic Slider Bearing," presented at the ASLE-ASME Lubrication Conference, Chicago, October, 1961, 6 pp.

hydraulic

Vessel Nozzles in Piping Flexibility Analysis

P. G. Stevens, head engineer, and R. B. Bell, associate staff engineer, American Oil Co, Whiting, Ind., and V. J. Groth, Sperry Rand Corp., Minneapolis, Minn.

Analysis of the thermal expansion and contraction of piping systems.

Intermediate restraints, temperature variations along the main run and in branches, unknown erection strains, and even unknown fitting thicknesses plague the designer and force him into making simplifying assumptions. Research sponsored by the Pressure Vessel Research Committee of the Welding Research Council has made it possible to eliminate most of the major assumptions; namely, that vessel nozzles need to be considered as "fixed ends."

This paper demonstrates that it is now practicable through the use of PVRC results to consider vessel nozzles as elastically restrained ends in a traditional piping flexibility analysis.

ASME Paper No. 61-PET-7, "Vessel Nozzles and Piping Flexibility Analyses," presented at the Petroleum Mechanical Engineering Conference, Kansas City, Mo. Sept., 1961, 10 pp.

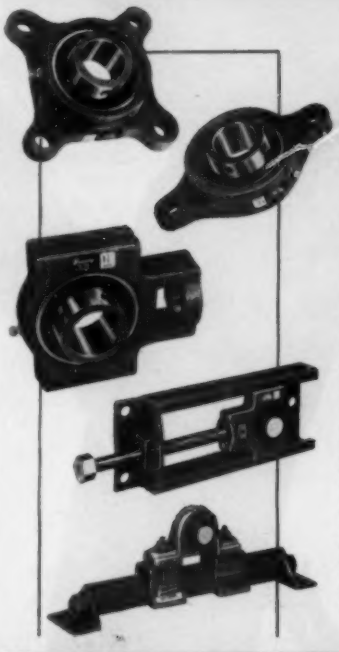
Solid and Liquid Propellant Information Agencies

Gertrude S. McMurray, Applied Physics Laboratory, Johns Hopkins University, Silver Springs, Md.

Description of the Solid and Liquid Propellant Information Agencies (SPIA and LPIA) which are maintained to effect rapid exchange of technical information on the government-sponsored propulsion programs.

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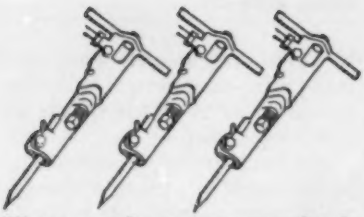
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The Porter Alloyist delivers the right alloy IN THE SPOTS THAT COUNT





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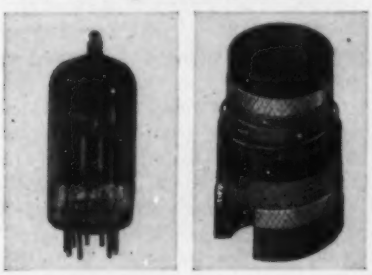


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ARS Paper No. 2198-61, "The Solid and Liquid Propellant Information Agencies," presented at the Space Flight Report to the Nation, New York, N. Y. October, 1961, 7 pp.

materials

Fatigue of Copper under Axial Load and Cyclic Strain

P. P. Benham, lecturer, Mechanical Engineering Dept., Imperial College of Science and Technology, London, England

Endurance-to-fracture test results for pure copper, annealed and cold worked, under axial conditions of constant-load cycling and constant-strain cycling.

Two mechanisms of deformation and fracture operated during load

cycling. In the higher load ranges, a behavior termed "cyclic creep" led to a necked-out type of fracture. This was succeeded at lower loads and longer endurances by a conventional fatigue mechanism and fracture.

Strain range during load cycling and stress range during strain cycling vary rapidly at the beginning of a test, but thereafter tend toward or attain a steady value which is maintained until the specimen approaches the point of fracture. This is caused by hardening of the annealed material and softening of the cold-worked specimens.

Strain and load-cycling results can be compared only after hardening or softening has occurred.

The material appears to work toward a steady cyclic condition which is virtually independent of its pre-test condition (hardness) and the type of cycling (load, strain, mean value).

Institute of Metals Paper No. 2068, "Axial-Load and Strain-Cycling Fatigue of Copper at Low Endurance," Journal of the Institute of Metals, Vol. 89, 1960-61, pp. 328 to 337.

techniques

Data Compression Through Selective Monitoring

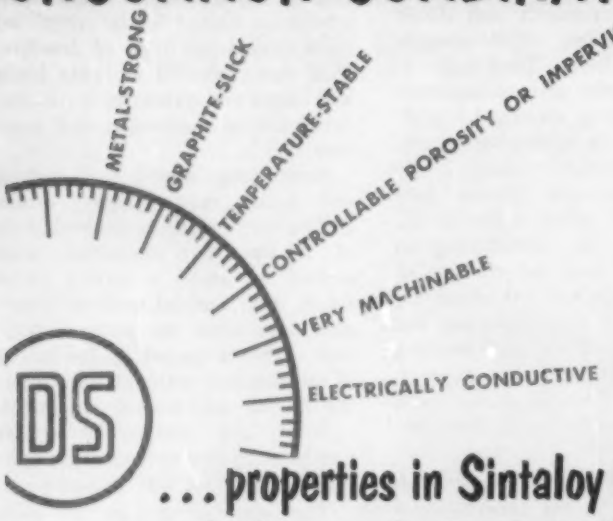
R. G. Cromleigh, Space-General Corp., Glendale, Calif., and B. N. Posthill, North American Aviation Inc., Anaheim, Calif.

Screening of original matter to obtain more efficient data acquisition and transmission systems.

In particular, it is desired that this efficiency be related to a maximum of useful information transmitted with minimum volume, weight, and power. Present equipment is involved in data acquisition and transmission from satellite and space vehicles in extended flights.

The view has been advanced that a data acquisition system should be designed to select for rejection all those signals which are known to be of no value to those who will interpret the system output. This is especially practical from an operational standpoint in early applications of selective monitoring techniques, since it is much more feasible to determine which signals can

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be agreed upon as really nonsignificant than to attempt to obtain agreement as to which signals are really significant.

The basic concept of selection can be broadened to include schemes in which more sophisticated editing is accomplished. Data reduction, prediction, and adaptive control techniques are among those suggested which could provide bases for reducing the quantity of data at the output of a data acquisition system.

ARS Paper No. 2082-61, "Data Compression Through Selective Monitoring," presented at the Space Flight Report to the Nation, New York, N. Y., October, 1961, 9 *pp.*

Applications of the Plasma Arc

R. L. O'Brien, Linde Co., Div. of Union Carbide Corp.

Description of the plasma arc cutting process and the apparatus used. After discussing the application of this process to various materials, other uses for the plasma arc are reviewed.

Compared to oxy-fuel gas cutting, which attains melting temperatures by chemical reaction, plasma arc cutting uses electrical energy. With both cutting processes, the removal of molten material is accomplished by high-velocity jets of gas. A plasma arc cuts any good electrical-conducting material. The chemical flame, on the other hand, cannot be used to cut materials, such as aluminum, which form a refractory oxide when heated and exposed to oxygen.

Plasma arc torches can be divided into two basic groups: Transferred arc and nontransferred arc. The transferred-arc torch uses the workpiece as the anode in the electrical circuit. The arc is "transferred" from the tungsten cathode to the workpiece. Thus, the transferred-arc type of device is used on an electrical-conducting workpiece. The nontransferred arc torch uses its own nozzle as the anode.

Nonferrous Materials: Originally, the plasma arc torch was commercially regarded chiefly as a cutting tool for aluminum. As first introduced, plasma-arc cutting with the transferred arc was recommended for cutting aluminum plate up to

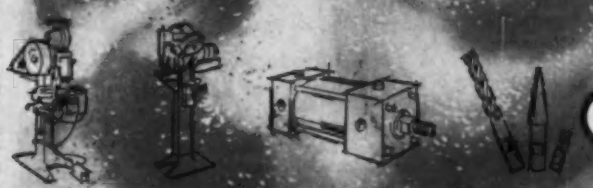
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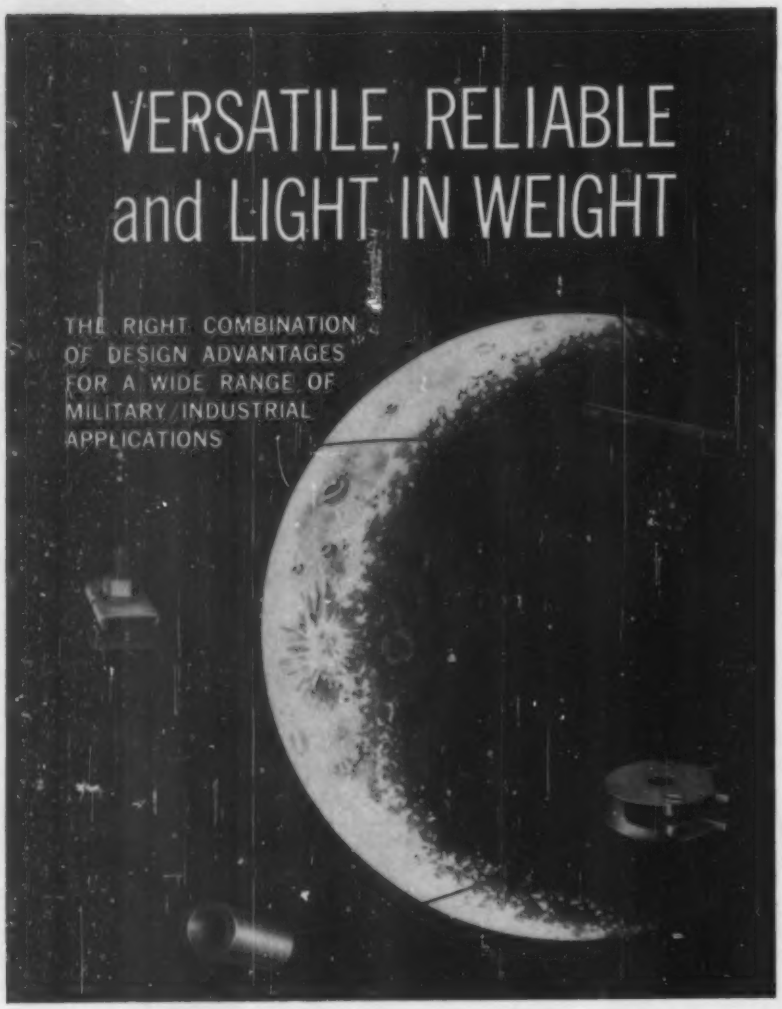
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Circle 316 on Page 19

1.5 in. thick. Now the process can cut aluminum plate up to 5 in. thick, stainless steel to 4 in. thick, and comparable thicknesses of copper, magnesium, and many other metals.

Plasma Arc Plating: The ability to independently control temperature and atmosphere is the principal advantage of the plasma arc coating. Thus, oxidation and a high melting temperature are not material limitations when the plasma arc is employed.

The advantages are illustrated when tungsten is deposited on a surface. The 6160 F melting point of this metal, together with its affinity for oxygen at elevated temperatures, presents no problem to the plasma arc operating with pure argon. Tungsten has been applied as a coating in thicknesses from a few mils to ½ in. on metals and graphite.

In general, good coatings can be made from most metals, most of the refractory oxides, and many of the refractory carbides. They have a good bond to most base materials, including graphite. The coatings are dense, usually laminar in structure, and may be highly finished.

Plasma Arc Weld Surfacing: Plasma-arc weld surfacing, the most recent development in the plasma-arc field, in contrast to the plating process, produces deposits fully fusion-bonded to the workpiece. As a process, plasma-arc weld surfacing produces thinner deposits than other arc or gas surfacing processes. Deposits being fused and welded can have 100 percent of theoretical density. Dilution can be controlled from less than 10 per cent to over 50 per cent.

SAE Paper No. 340H, "Applications of the Plasma Arc in Fabrication," presented at the National Aeronautic Meeting, New York, N. Y., April, 1961, 6 pp.

Introduction to the Theory of Reliability

R. P. Haviland, Missile and Space Vehicle Dept., General Electric Co.

How to arrive at a theory which will explain the occurrence of failures in objects, and which will permit calculation of time at which such fail-



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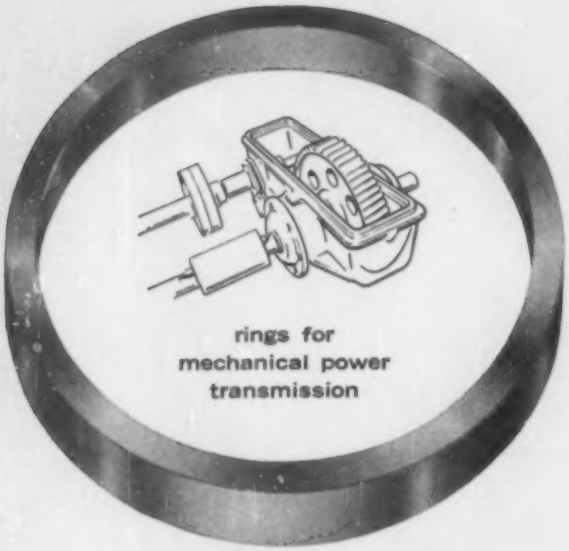
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ures will occur.

The starting point is the observation that the strength of an object is the strength of its largest flaw. However, instead of examining the statistical consequences of this, attention is paid to growth of the largest flaw with time. This leads to a series of equations which permit engineering calculations of life, and therefore, of reliability.

An object can be defined as a sample of material which has two specific characteristics of interest: Its strength and the fact that a load is supplied to it. The terms object, strength, and load are intended to be perfectly general. For example, an object might be a steel bar with a load applied in tension; it might be a piece of dielectric subjected to an applied voltage stress; or it might be an airplane in flight.

For simplicity, this paper considers only the general problem and basic equations.

SAE Paper No. 343D, "Introduction to the Theory of Reliability," presented at the National Aeronautic Meeting, New York, N. Y., April, 1961, 5 pp.

electrical

High-Density Digital Magnetic Tape Recording

C. N. Batsel, Jr., and W. L. Ross, Electronic Data Processing Div., Radio Corp. of America, West Los Angeles, Calif.

Problems and limitations of increasing the information transfer rate of magnetic tape systems by increasing information packing density.

It has been necessary to place certain explicit and implicit restrictions on the presentation since the art is so extensive. Explicitly, the paper is restricted to read/write techniques only. Implicitly, it is restricted to consideration of ferrous-oxide coated tapes, laminated head structures, and specific methods of modulation of the magnetization on the tape.

It is shown that packing densities in the order of 6000 flux reversals per inch are possible for computer usage provided suitable precautions, such as redundant recording, are taken to insure reliability. At packing densities in the order of 2500 flux reversals per inch, the in-



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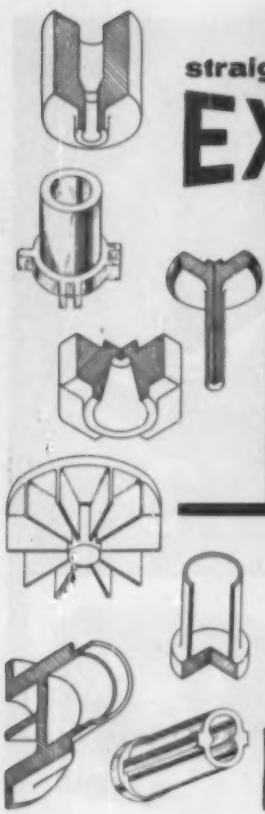
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creased reliability would appear to permit the use of more conventional techniques.

For the system discussed, the information transfer rate is principally limited by charactersistics of the tape itself, head design, head-to-tape contact, and system cost. Advancements in tape, head, transport, and system design may extend the range of useful packing densities for digitally recorded information.

WESCON Paper No. 13/2, "High Density Digital Magnetic Tape Recording," presented at the 1961 Western Electronic Show and Convention, San Francisco, August, 1961, 8 pp.

mechanical

Efficient Use of Automatic Test Equipment

James M. Rescoe, Hughes Aircraft Co., Culver City, Calif.

Introduction to the maintenance problem for modern military systems.

The paper summarizes the growth in complexity of these systems and the consequent reliability and maintenance problems which have been generated. The role of automatic test equipment in providing a solution is developed. It is demonstrated that automatic checkout equipment can, in principle, support and enhance the reliability of the prime systems through more thorough testing and, in some cases, by failure prediction. Automatic test equipment can reduce costs, time, and skilled manpower required for maintenance.

To achieve a significant fraction of the potential advantages of automatic test equipment, the prime equipment—from its earliest preliminary engineering through production design—must be designed for testability. The ground rules of system design for testability are developed. Within these rules, adequate design for testability is possible and optimal trade-offs between system performance, operational reliability, and maintenance requirements can be determined. Design for testability must permeate the entire engineering and design affort. The important points of data access, instrumentation, and isolation are covered in detail for both reliability and per-

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Technical-ities

by Fred E. Graves

Nuts have performance 'designed in'

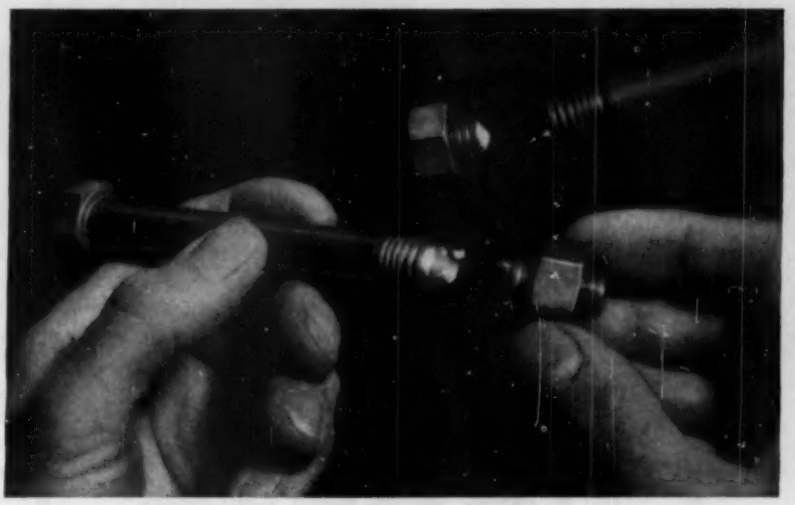
A standard nut isn't as simple as it looks. Much design know-how goes into its manufacture. Proper design avoids these pitfalls.

1. Thread shear: Several factors cause this. The nut may not be high enough to contain sufficient threads; its material may lack plasticity that enables it to deform under tightening so that enough threads engage and distribute the load to avoid progressive shear.

2. Wall dilation: The inclined-plane effect of the thread's helix angle resolves torque on a nut into two components: vertical (shear) and horizontal (dilation). Dilation enlarges nut's diameter, shifting the load towards weaker *tips* of threads.

3. Crushing: Nuts that aren't wide enough across the flats bear down on too small a surface. High unit stress may crush the bearing surface, with relaxation of bolt tension the undesirable end result.

Reputable fastener manufacturers provide you with ASA "Finished" nuts having enough height to sustain high thread tension, sufficient wall thickness to control nut dilation under load, and the right amount of bearing area. Nuts manufactured for ASA's "Heavy" series are higher and ⅛-inch wider across flats for added bearing area and wall thickness. They are generally used with high strength bolts or when bolt holes have large clearances.



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In a brute force test of strength, sintered stainless-steel nuts and cold-headed standard hex screws were assembled and pulled apart in a tensile tester to determine what would fail first.

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Size	Material	Proof Load (lbs.)
¼-20	*Brass	2060
¼-20	**18-8 Stainless Steel	3800
⅜-16	*Brass	5000
⅜-16	**18-8 Stainless Steel	9300
½-13	*Brass	9200
½-13	**18-8 Stainless Steel	17050

*Equivalent to screw stress of 65,000 psi
**Equivalent to screw stress of 120,000 psi

OTHER PHYSICAL ADVANTAGES

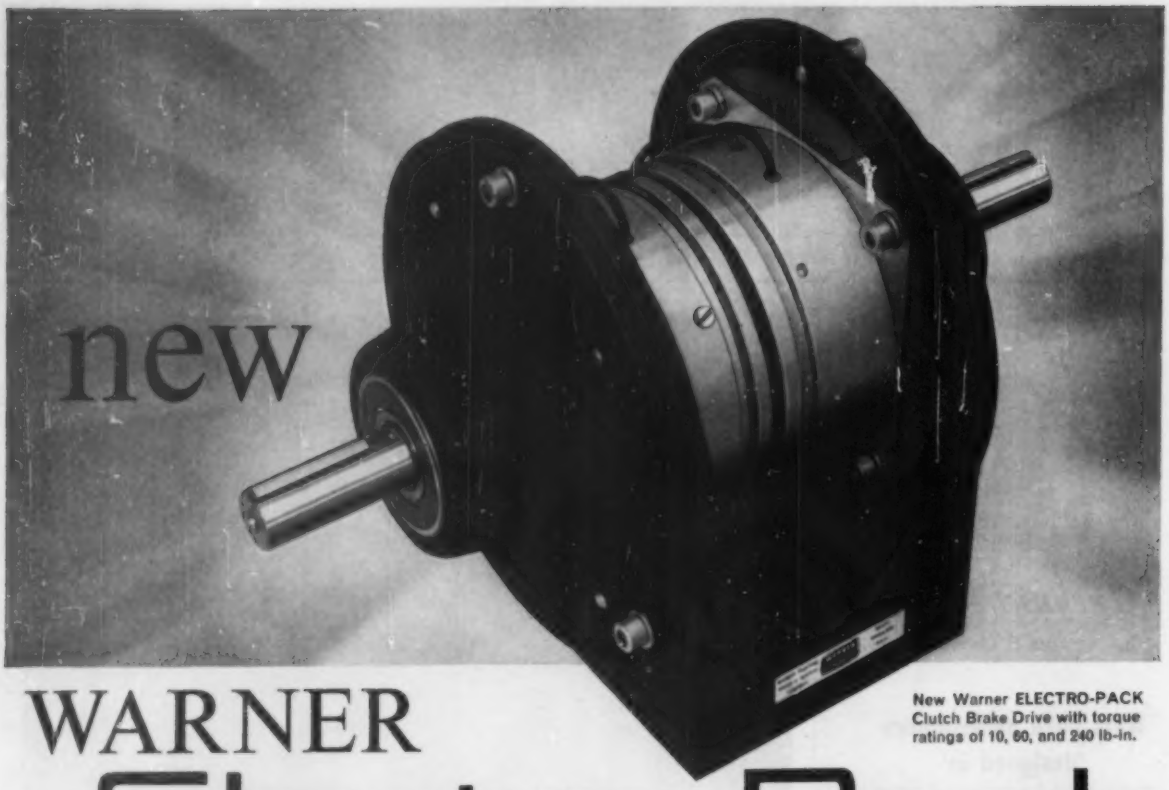
These nuts have excellent surface finish. Holes are perfectly round; threads are thus precisely tapped.

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formance.

WESCON Paper No. 24/2, "System Design Considerations for Efficient Use of Automatic Test Equipment," presented at the 1961 Western Electronic Show and Convention, San Francisco, August, 1961, 7 pp.

Instrumentation for Development of Internal-Combustion Engines

J. G. G. Hempson, head, Instrumentation Section, Ricardo and Co. Engineers Ltd., Shoreham-by-Sea, England

A discussion of the broad principles of transducers, and some reasons for use of varied measurement techniques in internal-combustion engine development.

Practical examples of pressure, movement, strain, and vibration measuring systems are given with reasons for choice of the method used. Some experiences with strain gages in special circumstances are mentioned. Normal temperature measurements are not discussed, but certain particular cases, such as differential thermometers and probes for dynamic measurement, are mentioned. The many uses of scaling or counting equipment are outlined with some examples, such as accurate tachometry. The visual disply units and photographic recording gear used to present the output from transducers are described together with some mention of driver amplifiers and carrier systems which are also needed. The problems of time-sweep generators and marker pulses are presented together with an outline of better solutions not yet achieved.

IME Paper No. ADP3/61, "Instrumentation Problems of Internal-Combustion Engine Dvelopment," to be presented at a meeting of the Automobile Div., London, England, December, 1961, 18 pp.

Combustion Control in Compression-Ignition Engines

A. R. Ibrahim, acting dean, High Industrial Institute for Teachers, Egypt, and E. T. Vincent, professor, Mechanical Engineering, University of Michigan

How engine speed can be limited by the delay and rate of combustion.

If the rate is high and complete air and fuel mixture is achieved, the after-burning will be short, en-

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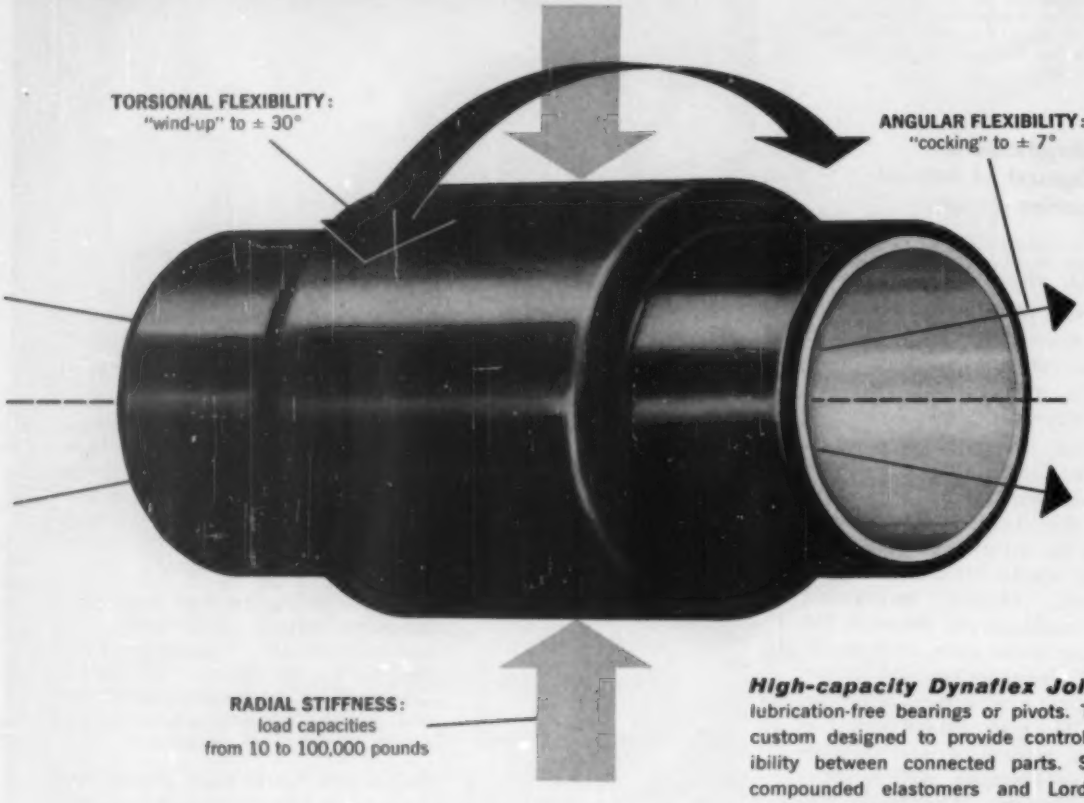
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Test results showed that the combustion lag does depend to a definite degree upon the precombustion reactions and that acceleration of both the lag and combustion can be effected by encouraging such prereactions to occur early in the cycle. Such increase in the speed of reaction can be used to increase engine speed without reduction of mean pressure in order to improve the specific outputs of the compression-ignition engine.

A moderate increase in the rate of combustion could be tolerated in the engine under test without inducing rough combustion and noise.

SAE Paper No. 401A, "Control of the Combustion of Compression Ignition Engines," presented at the Heavy-Duty Vehicle Meeting, Milwaukee, September, 1961, 9 *pp.*

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ARS—American Rocket Society, 500 Fifth Ave., New York 36, N. Y.

ASME—American Society of Mechanical Engineers, United Engineering Center, 345 East 47th St., New York 17, N. Y., papers 50 cents to members, one dollar to nonmembers.

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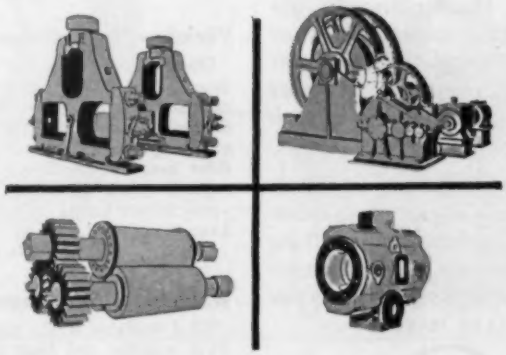
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MUELLER HAS THE METHODS . . . when you "Let Mueller Make It", you are utilizing one single source that is able to produce parts any one of these ways: as forgings, impact extrusions, sintered metal parts, screw machine products, formed tube or as castings.

MUELLER HAS THE METALS . . . and the materials . . . to produce precision parts in aluminum, brass, bronze, copper, iron, and steel in hundreds of different alloys to meet each exact requirement.

In addition, Mueller Brass Co. has complete and modern facilities for performing all types of finishing and sub-assembly operations. Another plus value is nation-wide sales engineering service.

So, in the final analysis, no matter where you fit in the American industrial picture, whether you're making missiles or mowers . . . and no matter where you're located, it will pay you to LET MUELLER MAKE IT!

MUELLER BRASS CO.
PORT HURON 20, MICHIGAN

Helpful Literature for Design Engineers

For copies of any literature listed, circle Item Number on Yellow Card—page 19

High-Temperature Bearings

Describes Haynes Alloy 25 deep-groove, corrosion-resistant bearings with full complement of balls not requiring loading slots or low shoulders. Bulletin shows cross-section views of bearings with materials and temperature ranges, tolerances, and general applications. Tech-Tonic 11, 3 pages. Industrial Tectonics Inc., 18301 Santa Fe Ave., Compton, Calif.

Circle 601 on Page 19

Portable Tensile Testers

Gives complete specifications for Model TT tester, designed for testing the breaking strength of electrical leads, terminals, and connectors, and Model TJ unit, equipped with two automatic jaw pairs for tensile testing of small parts or material samples as well as electrical leads and connections. Available capacity ranges and the accuracy of each is noted in tabular form. Bulletin 750/P, 4 pages. Hunter Spring Co., Div., American Machine & Metals Inc., Lansdale, Pa.

Circle 602 on Page 19

High-Alloy Castings

Covers high-alloy castings in static, centrifugal, and shell-molded types. Lists the ACI nomenclature, metallurgical properties, and uses of 55 alloys for the chemical, petrochemical, and metal-treating industries. Emphasis is given to HOM alloy for castings to be used at 2100-2200 F. Duraloy Co., Scottdale, Pa.

Circle 603 on Page 19

Variable-Power Drives

Discusses torque-rated Vari-Power machine drives with direct coupler reducer, variable-speed pulley, or timing-belt connection. Shows how the units operate, gives examples of applications, and provides data on selection. Catalog 761, 8 pages. Ferguson Machine Co., Div., Universal Match Corp., 7818 Maplewood Industrial Court, St. Louis 17, Mo.

Circle 604 on Page 19

Weldable Strain Gages

SR-4 weldable strain gages afford electrical stability and high linearity of response over temperatures from cryogenic through 750 F, and offer temperature compensation to plus or minus one part per million per deg F from 50 through 250 F. Data sheet gives illustrations and provides technical information on use of the gages for applications where standard types of strain gages cannot be used. Also gives temperature-coefficient curves, shows variation of gage factor with temperature, and provides design and application data. Data Sheet 4324, 2 pages. Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp., 42 Fourth Ave., Waltham 45, Mass.

Circle 605 on Page 19

Rotary Electrical Equipment

Briefly describes products available, including ac or dc miniature motors, gear motors, gyroscopes, servos, blowers, and synchros. Units are custom-made to requirements. 4 pages. Siemon Mfg. Co., P. O. Box 275, Wayne, Ill.

Circle 606 on Page 19

Valves and Cylinders

Covers popular models in standard line of valve and cylinders. Contains data on keeper-ring and tie-rod types of cylinders and hydraulic directional and functional flow valves. Mounting styles and connections are also illustrated. 4 pages. Rivett Lathe & Grinder Inc., Brighton 35, Boston, Mass.

Circle 607 on Page 19

Self-Sealing Fasteners

Covers four types of self-sealing fasteners, two available with Nylok thread inserts. Provides information on Seelskrews, Seelbolts, Seelrivets, and Kapt-Oskrews for high-pressure sealing applications. Contains specifications on each type of fastener, including temperature range, pressure range, corrosion-resistance, military specifications met, sizes and styles available, and installation instructions. Catalog H61, 4 pages. A.P.M. Corp., 41 Honeck St., Englewood, N. J.

Circle 608 on Page 19

Fluorosilicone Data

Three bulletins contain properties charts, performance charts, and graphs, and list suggested applications for fluorosilicone fluids, greases, and compounds. Bulletins 15-200, 15-201, 15-202, 8 pages. Dow Corning Corp., Midland, Mich.

Circle 609 on Page 19

Integral-Horsepower Motors

Pictures actual applications for four-cycle, 4 to 24-hp motors. Describes each motor, gives curves, specification data, dimensions, equipment available for special applications. Form EN403, 12 pages. Kohler Co., Kohler, Wis.

Circle 610 on Page 19

MUELLER CAN MAKE MOST ANYTHING IN SINTERED METAL PRODUCTS...

Sintered metal gears, cams, special purpose filters and structural members from iron, nickel, stainless steel, brass and copper alloys are produced by Mueller for practically every segment of American industry. Whatever your product requirements are, the Mueller Sintered Metal Products Division is completely equipped to supply you with precision parts to exact specifications at substantial savings. In addition, the engineering staff, machining and finishing facilities of Mueller Brass Co. are an important plus value when you

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339

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Representatives in all principal industrial areas

HELPFUL LITERATURE

Nylon Shapes

Gives data on nylon stock shapes, and includes physical properties of four grades of Cadco nylon. Available sizes and typical applications for Cadco nylon rod, plate, sheet, strip, and tubing are listed. Data on moisture conditioning, machining, bonding, welding, and coloring of nylon parts are given. 8 pages. Cadillac Plastic & Chemical Co., 15111 Second Ave., Detroit 3, Mich.

Circle 611 on Page 19

Instrument Counters

Describes mechanical and electrical instrument counters. Provides specifications and detailed descriptions of some of the special applications to which the counters have been adapted. Catalog 400, 16 pages. Durant Mfg. Co., 1933 N. Buffum St., Milwaukee 1, Wis.

Circle 612 on Page 19

Glassed Pump

Describes 1-in. Goulds-Pfaudler glassed pump for highly corrosive pumping applications with capacities to 75 gpm. Gives construction details, specifications, performance curves, and dimensions. Bulletin 725.3, 4 pages. Goulds Pumps Inc., 229 Black Brook Rd., Seneca Falls, N. Y.

Circle 613 on Page 19

High-Temperature Wires

Contains synopses of government wire specifications, government and commercial specifications, new-product news, tabulations on applicable military specifications, physical dimensions, dielectric strength, and temperature ratings. Covers magnet wire, Teflon-wrapped and extruded hook-up wire, miniature Teflon-lead wire, Teflon tubing, cables, FEP insulated wire, and Teflon tape. 58 pages. Hitemp Wires Co., Div., Simplex Wire & Cable Co., 1200 Shames Drive, Westbury, L. I., N. Y.

Circle 614 on Page 19

Bypass Rotameters

Describes how measurement and control of flow rates in pipe sizes as large as 48 in. can be accomplished through use of bypass rotameters. Provides information on capacity determination, flow range, piping requirements, accuracy, and other details concerning the use of rotameters in bypass arrangement. Bulletin 116, 8 pages. Brooks Instrument Co., Inc., Hatfield, Pa.

Circle 615 on Page 19

Foot Switches

Includes latest information on heavy cast-iron foot switches. Features common to all CR150 switches, plus features of different forms are pictured. Discusses five types, 14 forms of foot switches available. Selection guide includes nomenclature, stages, contact arrangement, and pedal operation. Bulletin GEA-7086A, 4 pages. General Electric Co., Schenectady 5, N. Y.

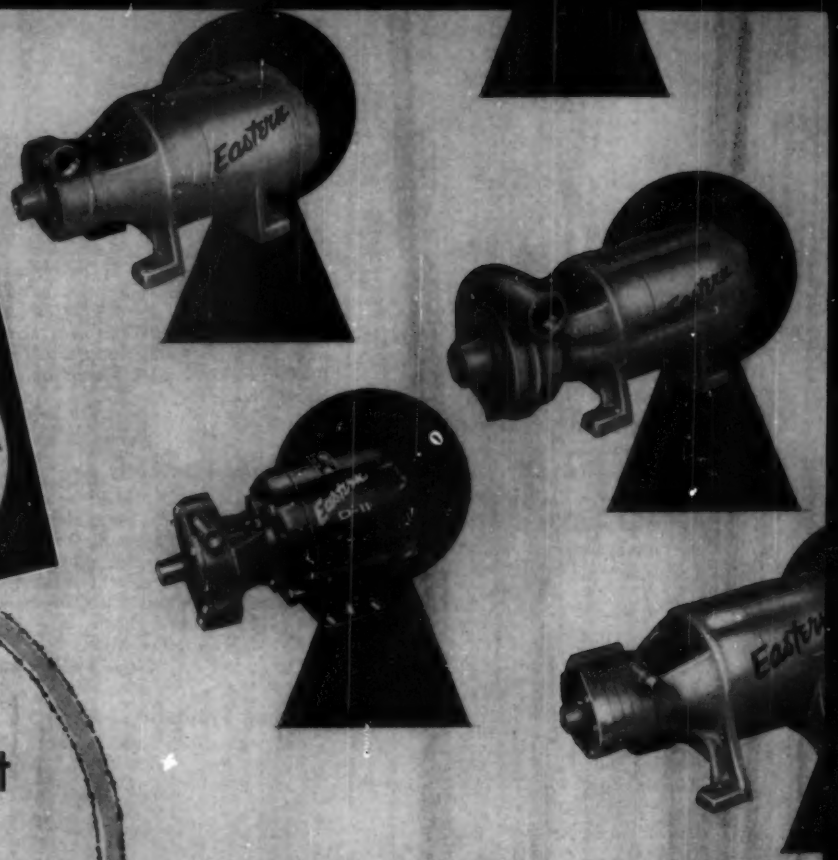
Circle 616 on Page 19

Circle 328 on Page 19

Circle 329 on Page 19→

Eastern





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A new catalog opens wide the doors to designers of process equipment — tells all you need to know in terms of engineering data, performance charts, seals, metals, mountings!

If you need centrifugal pumps with these characteristics, this reference book is for you:

- PRESSURES: to 21 psi in single stage pumps; to 70 psi in multi-stage types.
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- ENCLOSURES: drip-proof, totally enclosed, and explosion-proof ballbearing frames.
- DRIVES: Space-saving close coupled pumps most rugged and popular. Pedestal mounted arrangement without motor available as alternate for belt or coupling drive.
- SEALS: a variety of rotary seals and stuffing boxes, to fit every application.
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All told, 50 different models are described in full — and you get a wealth of technical data as well. Write for new catalog 130 now!

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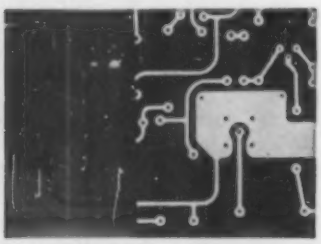
EASTERN INDUSTRIES, INCORPORATED

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WEST COAST OFFICE 4203 Spencer St., Torrance, Calif.

Straits Tin Report

Chemical tinning enhances the solderability of the conductive paths of printed circuits. Pure tin is deposited only on metal surfaces, including exposed edges; dielectric properties are unchanged.

The new process, using "CUPOSIT LT-26," made by Shipley Co., Inc., Wellesley, Mass., is not a substitute for electrodeposited tin, but it affords protection to the printed circuit board, thereby increasing storage life. "CUPOSIT LT-26" operates at temperatures lower than hot tin dipping, requires no electricity, contains no cyanide.



Bright side of printed circuit shows results of immersion in new chemical tinning process.

Tin Developments

- *Stronger titanium* results from addition of 15% tin. Ultimate tensile strength increases 90% at room temperature.
- *High-temperature brazing filler* metal alloys of tin, nickel, chromium, silicon keep joints strong after long exposure at high temperatures.
- *Low-melting quaternary* alloys of tin, indium, lead, silver are used for cryogenic circuits.

Free Bulletin

Write today for a free subscription to TIN NEWS—a monthly bulletin on tin supply, prices and new uses.



The Malayan Tin Bureau
Dept. T-29L, 2000 K Street, N.W., Washington 6, D.C.

Circle 330 on Page 19

HELPFUL LITERATURE

Hydraulic Power Packages

Describes motorized hydraulic power packages containing pump, electric motor, valving, and reservoir in one unit which can be used in practically any hydraulic application. Bulletin presents a run-down on design options, photographs of typical models, and a chart listing recommended motor sizes for various pressures and flows. Bulletin 61-82, 4 pages. Vickers Inc., Div., Sperry Rand Corp.

Circle 617 on Page 19

Cams and Camshafts

Includes face and cylindrical cams; two and three-dimensional cams; aircraft cams; master cams, and hydraulic pump cams. Cams for wrapping and packaging special machinery are also illustrated. Tolerance of the units is ±0.00001 in. Bulletin 210, 6 pages. Eonic Inc., 464 E. Hollywood, Detroit 3, Mich.

Circle 618 on Page 19

Welding Symbols

Chart gives data on basic weld symbols and their location significance, supplementary symbols, typical symbols use of supplementary symbols with welding symbols, and on basic joints. Printed on heavy, punched cardboard. Lenco Inc., 350 W. Adams St., Jackson, Mo.

Circle 619 on Page 19

Electronic Components

Includes data on tip plugs and jacks, as well as banana plugs and jacks, both non-insulated and insulated. Also discusses meter-type banana and tip plugs, test prods, binding posts, alligator clips, nylon tip jacks, and two and three-conductor phone jacks and plugs. Includes 11 types of molded pushbutton terminal blocks. 6 pages. National Tel-Tronics Corp., 52 St. Casimir Ave., Yonkers, N. Y.

Circle 620 on Page 19

Standard Lock Bolts

Includes specific information on standard lockbolts, tells how they work, lists application procedures, ordering information, and installation practices. Specification requirements are covered in detail. Bulletin T-194, 8 pages. Box 71-Z, Engineered Fasteners Div., Townsend Co., Ellwood City, Pa.

Circle 621 on Page 19

Data-Acquisition System

Describes MicroSADIC digital data-acquisition system, an integrated, high-speed, general-purpose, solid-state system capable of sampling several hundred channels of analog data at up to 15,000 samples per second. System converts analog information to equivalent digital form and records it on magnetic tape in either binary or binary-coded-decimal mode. Presents a brief functional description of major components. Bulletin 3047, 16 pages. Consolidated Systems Corp., 1500 S. Shamrock Ave., Monrovia, Calif.

Circle 622 on Page 19

SETKO

ISOTHERMAL HEAT TREATING

GIVES TOUGHER, CLEANER, SCALE-FREE FINISH



It's another reliability increasing feature from Setko to help you cut costs, yet, costs you nothing extra

Extensive use has proven that socket screw products treated by this process are tougher and cleaner. Threads, heads, points, shanks, etc. are scale-free. This means better fit, better performance, and it costs you nothing extra. It's another Setko exclusive in the socket screw field.

Standard on most Setko socket screw products

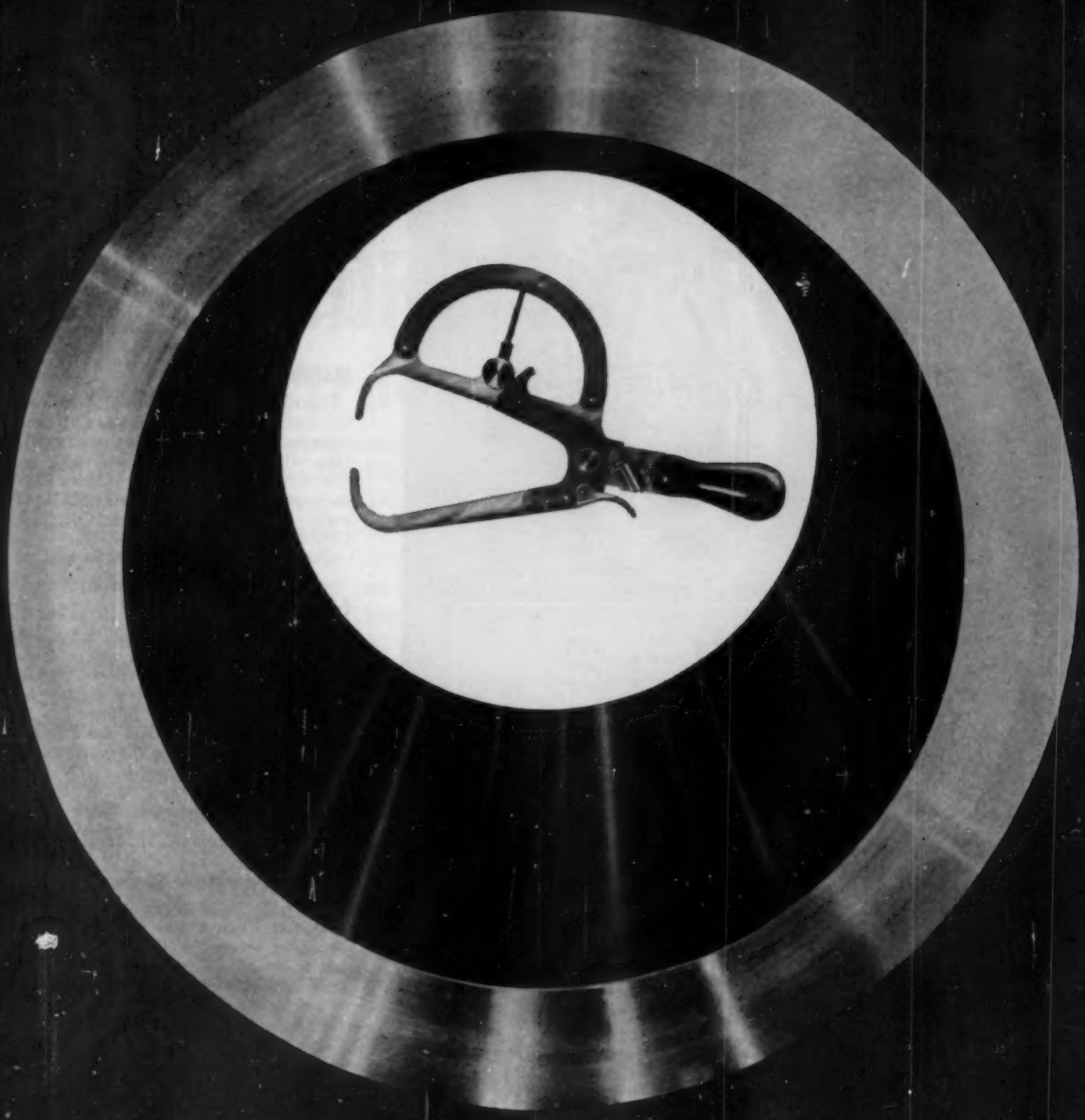
Isothermal heat treating is standard on most standard and special socket screw products including; hex socket, fluted socket, and slabbed head set screws as well as hex socket cap screws.



Write for test samples. Send us your specifications and requirements for advantageous quorations — Ask about the Setko Product Re-analysis Program and a copy of our catalog. Address requests on your company letterhead.

SETKO Set Screw & Mfg. Co.
28 Main Street Bartlett, Illinois
(Chicago Suburb)

Circle 331 on Page 19



NEW SIZE RANGE SURPRISE!

HERE'S A NEW PROCESS in centrifugally spun tubing that offers you greater freedom in design. It's ACIPCO CERAM-SPUN®... the new ceramic mold process* that is not limited by equipment sizes!

NOW, YOU CAN ORDER almost any combination of sizes you require. ACIPCO CERAM-SPUN® tubes offer O.D.'s from 2.25" to 50"; and wall thicknesses from .25" to 8". As-cast lengths are furnished from 4 feet to 20 feet, longer lengths are made by welding.

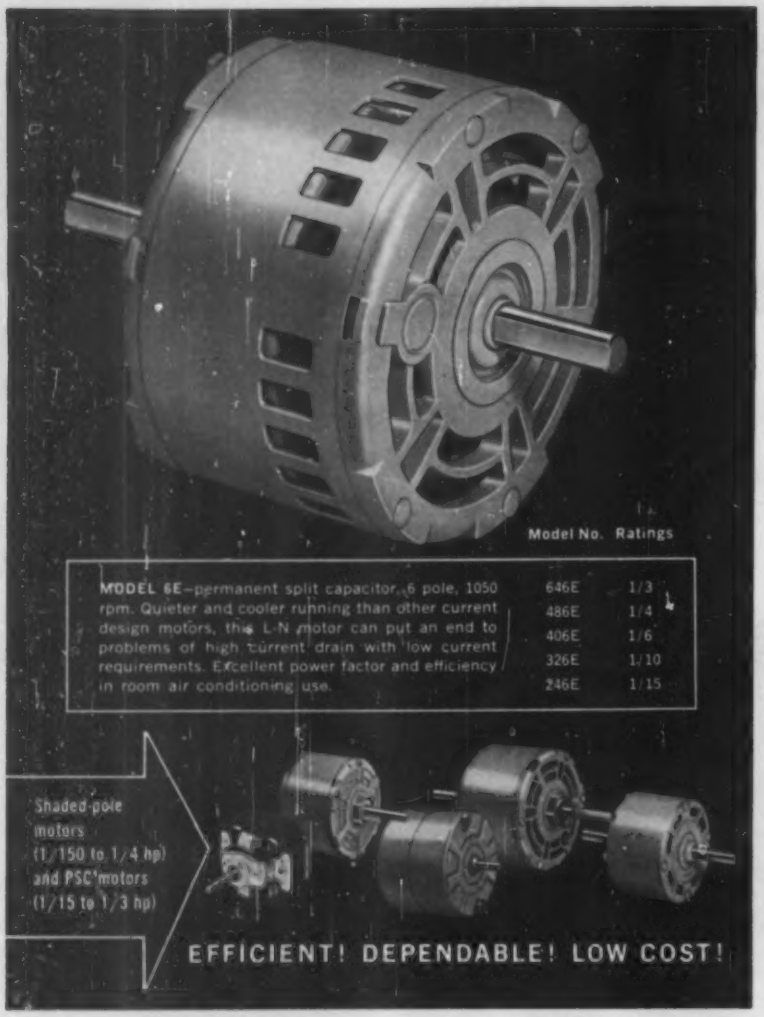
THINK OF HOW MUCH this process can save you! You'll avoid the cost of unnecessary metal waste, and excessive machining charges. And ACIPCO's complete "under one roof" operations — including heat treating, machining and welding — offer many additional economies. No need for the delays and excessive costs that often result in buying from multiple sources.

If you design, manufacture or use tubular component parts, it will certainly pay you to investigate the versatility of ACIPCO CERAM-SPUN® tubing and the flexibility of ACIPCO's integrated facilities. Contact **ACIPCO STEEL PRODUCTS,** Division of American Cast Iron Pipe Company, Birmingham 2, Alabama.

*Patent applied for

ACIPCO CERAM-SPUN®
STEEL TUBING

Circle 332 on Page 19



SPECIFY LEECE-NEVILLE MOTORS

to upgrade quality in air conditioners, refrigeration, pumps, fans, heating units

Leece-Neville offers you a complete line of shaded pole and permanent split capacitor A.C. motors and fractional D.C. motors —with horsepower ratings from 1/150 to 1/3 hp. All L-N motors are capable of meeting U.L. or C.S.A. application tests. Select a basic unit modified to your specification, or a special motor (custom engineered) to meet your requirements. Modern facilities assure top quality and delivery to your schedules. For complete information, write The Leece-Neville Company, Department MD-11, Georgia Division, Gainesville, Georgia.



D. C. MOTORS – Leece-Neville custom engineers more than 300 new D.C. Motors every year for car, home and industry. For details, write D.C. Motor Division, Cleveland 3, Ohio.

QUALITY ELECTRICAL EQUIPMENT
Leece-Neville
SINCE 1909

HELPFUL LITERATURE

AC Pump Motors

Describes two groups of ac motors for pump-duty service. Bulletin contains selection and specification tables, shows various mounting arrangements, speed-torque curves, principal dimensions, and pictures a number of special designs. Bulletin L-4121A, 6 pages. Kingston-Conley Inc., Plainfield, N. J.

Circle 623 on Page 19

Multipoint Gages

Describes multipoint gages for indicating draft, pressure, differential, and temperature. Lists standard scale ranges, provides diagrams and numerical data on mounting dimensions, and includes data on gage installation. Bulletin 322.11, 4 pages. Republic Flow Meters Co., 2240 Diversey Parkway, Chicago 47, Ill.

Circle 624 on Page 19

Lubricated Bearings

Covers Life-Lube permanently lubricated, ball-bearing pillow blocks, flange units, and take-up units, as well as porous-bronze and babbitted pillow blocks. Includes babbitted-bearing information on load ratings and maximum shaft speeds, and lists new two-hole flange units offered in shaft sizes from ½ to 7/16 in. Bulletin 7104, 12 pages. T. B. Wood's Sons Co., Chambersburg, Pa.

Circle 625 on Page 19

High-Temperature Seal

Describes Pallseal two-stage, stainless-steel and Viton-A seal for fluid systems operating between −65 and +500 F and up to 10,000 psi. Covers construction, materials, dimensions, and standard sizes available, and also includes information on ordering. Bulletin E15, 2 pages. Pall Corp., 30 Seal Cliff Ave., Glen Cove, N. Y.

Circle 626 on Page 19

Reinforced Plastic

General properties and thermal properties for Tayloron PA high-temperature, asbestos-base, reinforced plastic developed for rocket applications. Characteristics include excellent thermal insulation, good machining, heat resistance, good ablation performance in wide range of temperatures, high tensile and flexural strength, and good impact strength. Forms available are included. Bulletin 8.5, 2 pages. Taylor Fibre Co., Norristown, Pa.

Circle 627 on Page 19

Pumps and Components

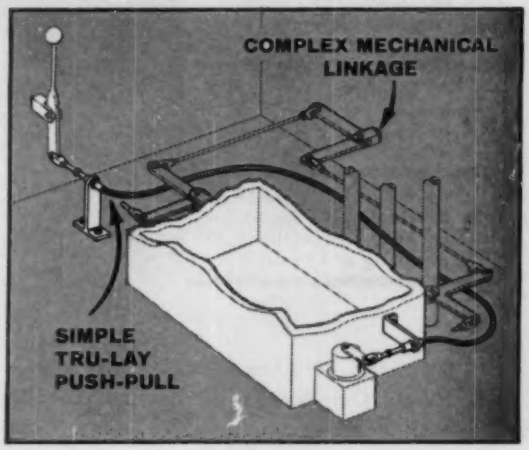
Explains and illustrates how electro-hydraulic, servo-controlled, one and two-way, variable-delivery pumps in capacities to 108 gpm and 3000 psi function. Also covers amplifiers, preamplifiers, preset units, manual units, transformers, transducers, control panels, consoles, cylinders, and hydraulic motors. Bulletin 47740, 20 pages. Oilgear Co., 1570Q W. Pierce St., Milwaukee 4, Wis.

Circle 628 on Page 19

ACCURATE REMOTE CONTROL FOR HUNDREDS OF PRODUCTS

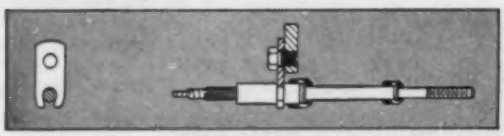
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If your products involve remote control—electrical, hydraulic, pneumatic or direct—TRU-LAY PUSH-PULL FLEXIBLE CONTROLS can help solve your design problems. They provide positive remote control over short or long distances—up to 150 feet from the control point. Because they operate while flexing, they can snake around obstructions. They will not buckle. They are ruggedly constructed, easily installed and operated, sealed against dirt and moisture, and will handle jobs with as much as 1,000 lbs. input. PUSH-PULL CONTROLS are simple, have but one moving part, are noiseless and give a lifetime of accuracy. Mechanical linkages, on the other hand, are complex. Unlike PUSH-PULL CONTROLS, they are made of many parts, wear at many points, and produce increased backlash, vibration rattles and lost accuracy.

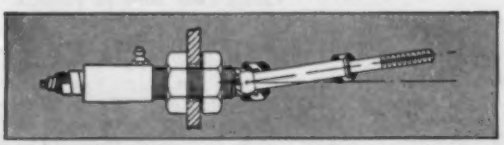


THESE FEATURES HELP SOLVE DESIGN PROBLEMS

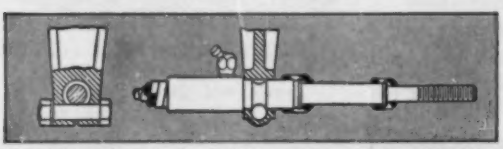
Anchorages



Clip anchorage • a simple clip for light loads

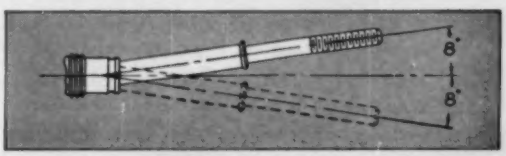


Bulkhead anchorage • for heavy-duty installations



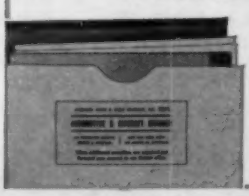
Machined bracket anchorage • can be furnished for mounting any PUSH-PULL cable at the swivel terminal

Swivel Action



Standard assemblies have end fittings with a swivel movement of ± 8° to compensate for misalignment and rise or fall of lever arms. Swivel joints, and the sliding ends, are sealed against dirt and moisture.

PUSH-PULL DATA FILE SHOWS HOW TO SIMPLIFY, IMPROVE DESIGN



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ACCO

PUSH-PULL CONTROLS

Automotive and Aircraft Division • American Chain & Cable Company, Inc.

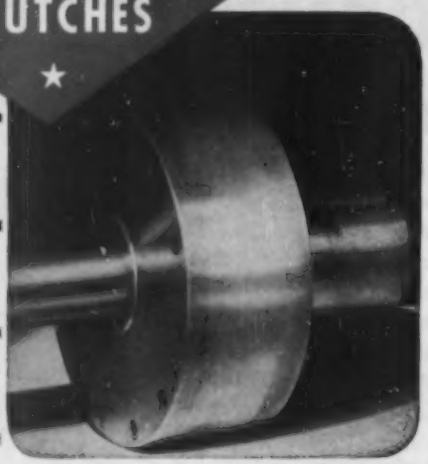
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Circle 334 on Page 19

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1. LONG LIFE because the rolls have no localized wear points.
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3. ACCURATE because of individual spring pressure on each roll.
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- BACK STOP SERVICE on textile machines, speed reducers, elevating conveyors and in combination with ratchet feeds.
- WRITE TODAY FOR BULLETIN 231 WITH COMPLETE INFORMATION.

OTHER HILLIARD CLUTCHES:

SINGLE REVOLUTION CLUTCHES for automatic accurate control—electrical or mechanical—of intermittent motion, indexing, cycling and cut-off. Ask for Bulletin 239.

SLIP CLUTCHES for overload protection, or constant torque and to provide constant tension and permit speed variation on rewind stands. Ask for Bulletin 300.

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HELPFUL LITERATURE

Dry Lubricant

Typical applications of Molykote G grease-type lubricant are included in a new bulletin. Ability of the material to prevent galling, seizing, fretting, and metal pick-up is described. Describes the lubricating characteristics of the material and gives application instructions. Bulletin 131, 2 pages. Alpha-Molykote Corp., 65 Harvard Ave., Stamford, Conn.

Circle 629 on Page 19

Optical Terminology

First in a continuing series of terminology glossaries covers a wide range of technical optical terms from "aberrations" to "surface reflection." Printed on three-hole-punched paper. "Glossary of Optical Terminology," 1 page. Servo Corp. of America, 111 New South Rd., Hicksville, L. I., N. Y.

Circle 630 on Page 19

Impulse Transmitters

Illustrates and describes five basic Sodeco impulse transmitters which transform motion into electrical counting impulses. Specifications and dimensional drawings are given on rotary-motion unidirectional, rotary-motion bidirectional, lever-actuation, fixed-time ratio, and adjustable-time ratio types. Variations of the standard types are also listed. 4 pages. Landis & Gyr Inc., 45 W. 45th St., New York 36, N. Y.

Circle 631 on Page 19

Light-Duty Conveyor Chains

Details Rex Table-Top and Plate-Top chains of various materials. Includes section on selection of these two conveyor chains, and on conveyor design. Also lists other light-duty chains. Bulletin 6158, 40 pages. Chain Belt Co., Milwaukee 1, Wis.

Circle 632 on Page 19

Motor Bases

Covers three series of automatic motor bases. Details features of each series, including specifications and dimensional data. Includes data on mounting positions and on motor-base selection. 8 pages. Manheim Mfg. & Belting Co., Manheim, Pa.

Circle 633 on Page 19

Synchronous Motors

Covers bifilar and four-lead Slo-Syn synchronous motors. Includes charts, curves and circuit diagrams which provide ratings and dimensions. Form SE-L36161, 4 pages. Superior Electric Co., Bristol, Conn.

Circle 634 on Page 19

Power Control Units

Provides data on characteristics and operational details of power control units, rated from 1-15 kva. Includes circuit diagrams and list of typical applications. Bulletin 4-61, 8 pp. Magnetics Inc., Butler, Pa.

Circle 635 on Page 19

CASE HISTORIES FROM
MT. VERNON FILES

Who makes the die castings for the FABULOUS NEW IBM SELECTRIC?... MT. VERNON



This truly revolutionary IBM SELECTRIC typewriter is probably the most important breakthrough in office technology since the invention of the typewriter itself.

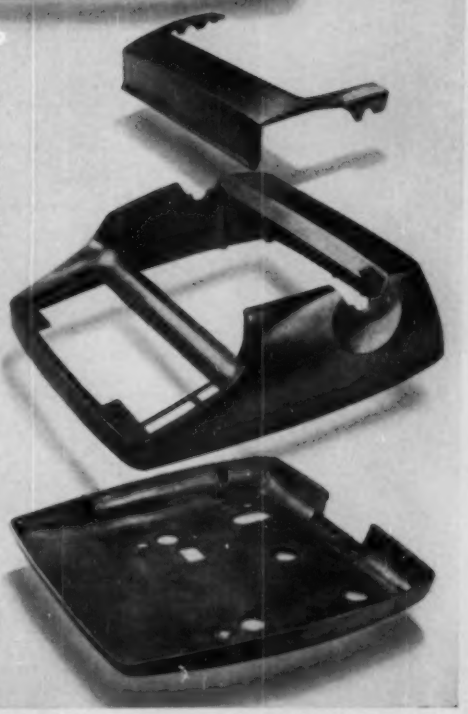
It is a brilliant example of engineering, workmanship and the imaginative use of materials and processes. Contributing to the beautiful appearance — and much lighter overall weight — are the 3 Mt. Vernon aluminum die castings that comprise the housing. They weigh only 5½ lbs.

As with IBM to whom Mt. Vernon has been a reliable supplier for several years, we also offer you our fourfold services and coordinated facilities for precision zinc and aluminum die castings.



1958 1959

We may be the "reliable supplier" you need to help you improve your products. Why not get in touch with us and talk it over? Our field salesmen are waiting for your call.



MT. VERNON DIE CASTING CORPORATION

Stamford, Connecticut



FIELD SALESMEN—BALTIMORE, MD.: Mr. C. M. Gordan, 919 St. Paul St. • **BROOKLYN, N. Y.:** Mr. Robert V. Moore, 2317 Plumb 2nd St. • **MARIETTA, N. Y.:** Mr. Burt J. Meldrum, Olanco Road • **PITTSBURGH, PA.:** Mr. Andrew W. Anderson, 300 Pasadena Drive So. • **STAMFORD, CONN.:** Mr. Anker Anderson, Cascade Road • **VALLEY FORGE, PA.:** Mr. G. T. McMaster, P. O. Box 115

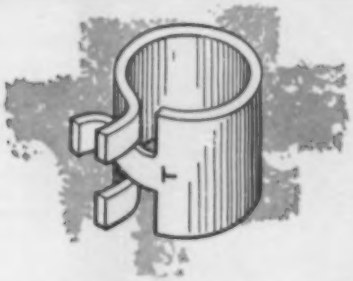
Circle 335 on Page 19

INFORMATIVE NOTES TO IMPROVE YOUR PRODUCT ...SAVE YOU MONEY

Published as a service to Designers and Engineers

Ideas from Tinnerman have cut costs, improved products. Here are examples from Tinnerman's 10,000 variations of SPEED NUT brand fasteners —all stamped with the T-mark of *total* reliability.

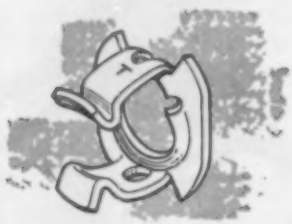
Tinnerman can help *you* cut costs with a free Fastening Analysis of your product. Call your Tinnerman representative, or write: *Tinnerman Products, Inc., Department 12, P. O. Box 6688, Cleveland 1, Ohio.*



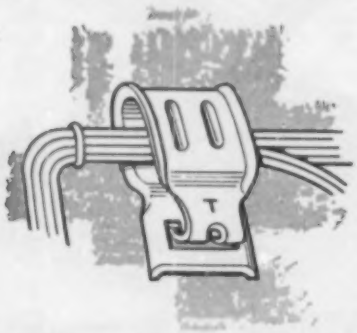
VERSATILE COMPRESSION RING has solved fastening problems in car radios, pressure gages, washers, and speaker cabinets. Simply squeeze compression fingers with pliers to expand . . . release, and spring tension maintains firm connection. Heat-treated spring steel of this SPEED CLIP® fastener won't lose tension, won't loosen under vibration. Possible applications are practically unlimited.



BOLT RETAINER used to fasten grille extensions to car fenders, has potential usage in any field where high-torque fastening is required on thin metal sections. This SPEED GRIP® fastener eliminates costly welding or staking, speeds assembly, allows savings in labor costs and parts handling. Barbs locate fasteners until nut is driven. One of Tinnerman's extensive line of SPEED GRIP nut and bolt retainers.



ELECTRONIC CONTROL CLIP retains tuning switch on chassis, gives constant spring tension for both push-pull and revolving controls . . . can be used wherever electronic controls are installed. This multipurpose SPEED CLIP fastener replaces threaded nuts, bushings, lockwashers. Cuts costs substantially. Live spring action lasts for the life of the equipment.



WIRE RETAINER is ideal for attaching single wire, light harness, cables or tubing. This SPEED CLIP fastener can be preassembled on the harness, allowing an entire wiring system to be snapped into place in seconds. Double embosses on upper clamping leg trap cold-flow tendencies of vinyl covered cord, assure 35 pound pull resistance. Clip will accept any wire or bundle up to .306" x .515".

CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerocessories Ltd., Treforest, Wales. FRANCE: Simmonds S.A., 3 rue Salomon de Rothschild, Suresnes (Seine). GERMANY: Mecano Simmonds GMBH, Heidelberg.

TINNERMAN *Speed Nuts*®

Look for the Tinnerman "T"

Valve Sizing

Explains in simple language exactly what appears in undersized, oversized, and correctly sized pressure-reducing applications. A typical example is given, dangers of missizing are pointed out, and advantages of correct sizing are indicated. Jordan Valve Div., Richards Industries Inc., 6013 Wiehe Rd., Cincinnati 37, Ohio.

Circle 636 on Page 19

Data-Recording Systems

New lightweight data-recording system that records 14 tracks of data with laboratory precision in missile environments is described. Includes photographs, diagrams, and specifications of the 2101 system. Brochure 3.11, 4 pages. Westrex Co., Div., Litton Systems Inc., Maple Drive, Beverly Hills, Calif.

Circle 637 on Page 19

Solenoid-Operated Brakes

Describes Type S brakes for applications where small, dependable brakes are required for holding or stopping. Contains ratings, wheel data, and dimensions of the ac solenoid-operated brakes, and lists many construction features and options. Publication LJ-75, 4 pages. Cutler-Hammer Inc., 328 N. 12th St., Milwaukee 1, Wis.

Circle 638 on Page 19

Humidity Meter

Describes Humidi-Meter unit which permits instant measurement of relative humidity. Points out chief features of the unit. Includes chart of comparison of commercially available humidity-measuring means. Form HI 25-961, 2 pages. Telostat Corp., 1003 First Street South Hopkins, Minn.

Circle 639 on Page 19

Cooling, Retention Devices

Describes electronic cooling and/or retention devices. Includes descriptions and technical data on tube clamps for retaining tubes and electronic components, tube top-holding retainers for various sizes of vacuum tubes, clamps for miniature plug-in tubes and components, JAN shield inserts for tubes, transistor retaining clips, and transistor/component heat radiators. Catalog 1W, 8 pages. Industrial Div., Birtcher Corp., 745 S. Monterey Pass Rd., Monterey Park, Calif.

Circle 640 on Page 19

Gate Valves

Covers King-clip gate valves, designed to withstand corrosive actions too severe for lighter valves. Gives reports on the applications, features, and designs of the two types. Lists steam pressure and water-oil-gas pressure ratings, as well as specific dimensions for different designs. Cutaway is included for parts identification. Circular 561, 4 pages. Lunkenheimer Co., Cincinnati 14, Ohio.

Circle 641 on Page 19

Circle 337 on Page 19→

LONG LIFE, *THOMSON* "Snap-In"

NYLINERS®

—*BEARINGS of smooth, tough DuPont* NYLON



Low Cost FLANGED Nyliner | Low Cost SLEEVE Nyliner | Low Cost DOUBLE-FLANGE Nyliner

COST LESS to BUY
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NYLINER Bearings are a highly engineered thin liner of DuPont Nylon, designed to bring bearing users the many benefits of Nylon as a bearing material by solving most of the limitations surrounding its use. The compensation gap principle assures maintenance of diametral tolerances for precision applications.

Seven Standard Types available from stock. Write for literature and name of your local representative who stocks NYLINER Bearings for immediate shipment.

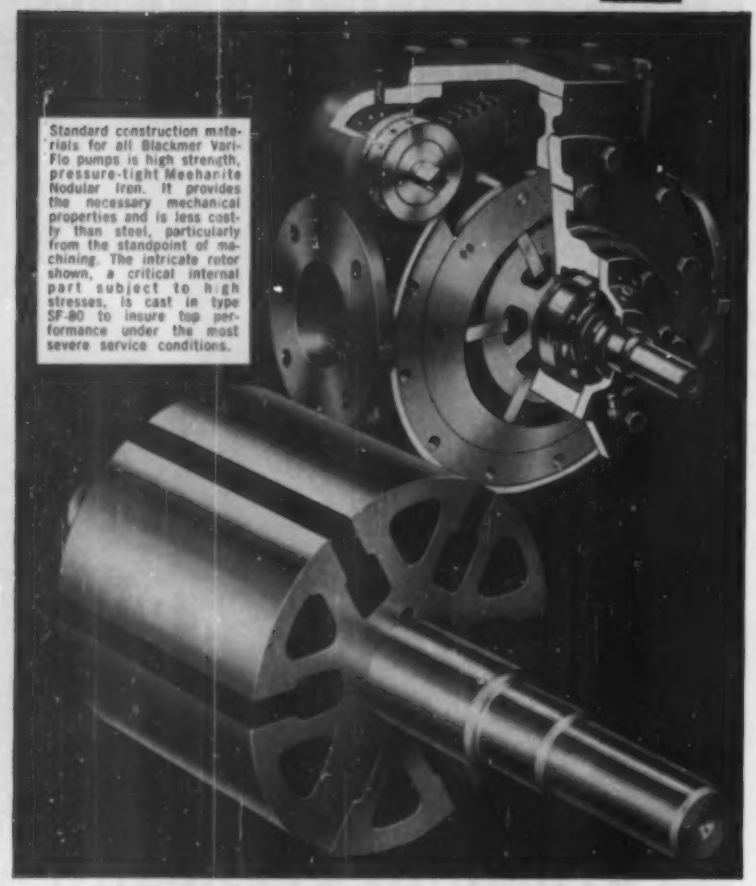


THOMSON INDUSTRIES, Inc.

DEPT. 4, MANHASSET, NEW YORK

Also— —Manufacturers of BALL BUSHINGS . . . the Ball Bearing for Linear Motions and 60 CASE . . . Hardened & Ground Steel Shafting

MEEHANITE MEANS BETTER CASTINGS®



Standard construction materials for all Blackmer Vari-Flo pumps is high strength, pressure-tight Meehanite Nodular Iron. It provides the necessary mechanical properties and is less costly than steel, particularly from the standpoint of machining. The intricate rotor shown, a critical internal part subject to high stresses, is cast in type SF-80 to insure top performance under the most severe service conditions.

SOLVE YOUR TOUGH CASTING PROBLEMS WITH MEEHANITE NODULAR

The excellent castability of Meehanite Nodular in combination with exceptional strength, ductility and wear resistance has led to its wide acceptance for intricate pressure castings and many other components which must withstand severe service conditions. The broad range of its utility is further enhanced by inherent production advantages resulting in a reduction of manufacturing costs.

Meehanite Nodular is available in a broad range of properties embracing all current Nodular specifications and including some unique new wear and heat resisting types. When you specify one of the S types of Meehanite Nodular, you can be sure of obtaining castings that live up to specified claims. Meehanite foundries have more than a quarter of a century of experience in handling the essential materials used to convert the graphite in cast iron from the flake form to the nodular which gives this family of metals its unique engineering properties. Meehanite patented quality controls assure uniform dependability regardless of how small or how large the casting.

For complete information about Meehanite Nodular, send for a free single copy of our eight page brochure (B-47-A). Write: Meehanite Metal Corporation, 714 North Avenue, New Rochelle, New York.

MEEHANITE METAL

MEEHANITE CASTINGS ARE MADE ONLY BY MEEHANITE FOUNDRIES.

Tiny Switch

Details material on Bi-Reed switch, with a body only 0.75 in. long. Lists characteristics of the switch, along with pertinent features. Also includes material on uses of the switch, and on the Bi-Reed relay package. Sheet BR-1, 2 pages. RBM Controls Div., Essex Wire Corp., Logansport, Ind.

Circle 642 on Page 19

Capacitors and Resistors

Includes quick-reference data on electrolytic capacitors, paper capacitors, MIL-type capacitors, metallized-paper capacitors, mica and ceramic capacitors, ac motor capacitors, plate assemblies, filters, and resistors. Many new types are incorporated. Catalog IDC-561, 56 pages. Aerovox Corp., 740 Belleville Ave., New Bedford, Mass.

Circle 643 on Page 19

Acrylic Molding Powder

Provides data on Implex R high-impact acrylic plastic molding powder. Advantages are listed as well as typical applications. Table includes data on average physical properties, and another provides material on chemical resistance. Bulletin PL-476, 4 pages. Rohm & Haas Co., Washington Square, Philadelphia 5, Pa.

Circle 644 on Page 19

RFI Gasket

Describes quick-installation RFI gasket, Teckstik. Details applications, RFI control rating, and available forms; includes material specifications, prototype prices, and ordering instructions. Data Sheet RF-15, 2 pages. Technical Wire Products Inc., 129 Dermody St., Cranford, N. J.

Circle 645 on Page 19

Tape Recorder-Reproducer

Gives a general description of the FR-100C magnetic tape recorder-reproducer. Includes detailed descriptions of tape transport and electronics, tape and reel sizes, tape speeds, controls, and recording modes. Ampex Corp., Box 5001, Redwood City, Calif.

Circle 646 on Page 19

Electronic Cabinet

Provides information on Unicabinet custom-built, electronic rack cabinet. Shows all standard and optional features, and gives details of construction. Complete specifications are included. Folder U101, 6 pages. Dahlstrom Mfg. Corp., East Second St., Jamestown, N. Y.

Circle 647 on Page 19

Zener Diodes

Two bulletins describe miniaturized silicon zener diodes for voltage regulation. Include performance features, pertinent electrical characteristics, and dimensions of the 1 and 10-w units. Bulletins 6.353, 6.354, 4 pages. Fansteel Metallurgical Corp., North Chicago, Ill.

Circle 648 on Page 19

SCULLY JONES **BALL SCREWS** *produce FRICTION-FREE motion reduce POWER requirements, simplify design*

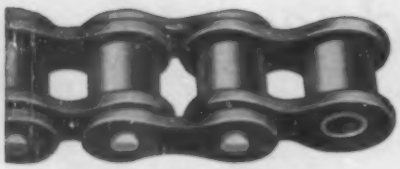


Scully-Jones internal ball return simplifies nut mounting of ball screws. Compact, clean design keeps nut small in relation to screw . . . maximum rigidity and strength for limited space. Available in single-nut or double-preloaded-nut assemblies.

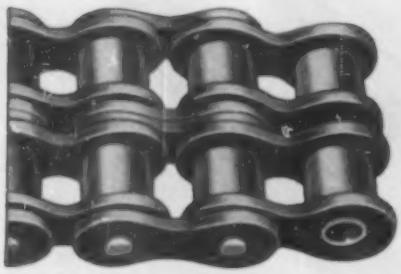
Matched Scully-Jones recirculating ball screws provide a smooth broach pull on this Lapointe vertical broaching machine. Antifriction pull through the rugged ball screws eliminates chatter . . . lengthens tool life . . . improves work finish. Scully-Jones Super-Cision ball screws have a mechanical efficiency of 90% or more—simplify lubrication and reduce power requirements. Designed to fit your needs. Write today for Bulletin 25-50.

Special Products Division SCULLY JONES **Scully-Jones and Company**

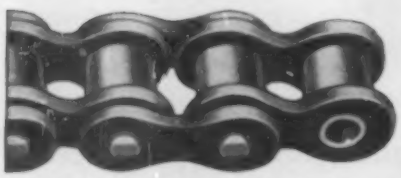
1905 South Rockwell Street, Chicago 8, Illinois



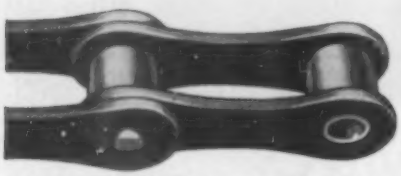
SINGLE STRAND



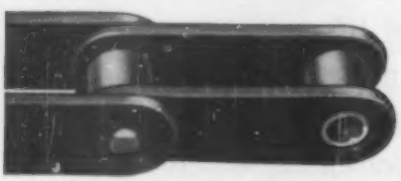
DOUBLE STRAND



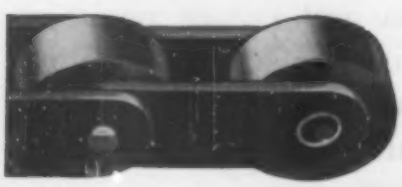
SINGLE STRAND, HEAVY SERIES



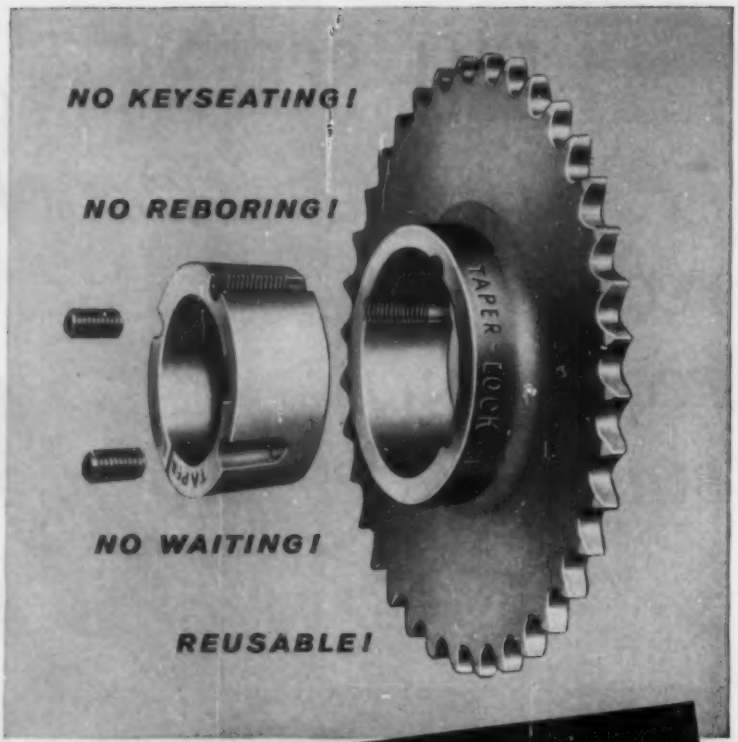
DOUBLE PITCH TRANSMISSION



DOUBLE PITCH CONVEYOR



DOUBLE PITCH CONVEYOR, LARGE ROLLERS



TAPER-LOCK SPROCKETS DODGE ROLLER CHAIN

DODGE Quality Roller Chain, teamed with Dodge Taper-Lock Sprockets, results in chain drives and chain conveyors that have the precision, efficiency and stamina necessary for the real economy of *long life*.

Moreover, Taper-Lock's reusable bushing makes a difference in overall cost. The ease of Taper-Lock mounting, the elimination of reboring, keyseating, and wasted time, add to the saving. Precision machining and true articulation lengthen the life of *both* sprocket and chain.

The Dodge line of chain, including standard attachments, is extensive. It meets a high percentage of all chain requirements.

In the Double Pitch series (both Transmission and Conveyor) the sizes which require special spacing for perfect tooth action are offered from stock in special double pitch design — to double the life of the chain and the sprocket!

Ask your local Dodge Distributor. Or write us for bulletin.

DODGE MANUFACTURING CORPORATION, 3300 Union St., Mishawaka, Ind.



CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look under "Dodge Transmissioneer" in the *white* pages of your telephone directory, or in the *yellow* pages under "Power Transmission Machinery."

DODGE
of Mishawaka, Ind.

Push-Pull Cable

Details how to determine load requirements, selection of proper core size, and other design requirements for push-pull control-cable applications. Also lists dimensional data, cable construction details, and recommended input loads for three sizes of push-pull cables. Form 162, 4 pages. Push Pull Cable Div., Morse Instrument Co., Hudson, Ohio.

Circle 649 on Page 19

Timing Instruments

Describes over 100 different timers, from a basic stopwatch to a synchronous chonoscope for measuring intervals to 0.01 sec. Complete data and specifications on construction, method of operation, size, and reading are given for each timer. 16 pages. Heuer Timer Corp., 441 Lexington Ave., New York 17, N. Y.

Circle 650 on Page 19

Miniature Delay Lines

Describes and illustrates Wee Line sectionalized delay line which provides fast solutions to delay-line problems, manufactured as a standardized, modular unit. Gives electrical characteristics, mechanical particulars, and mounting information. Operating information is included, as are design suggestions and typical problem solutions. Form S-53, 4 pages. Nytronics Inc., 550 Springfield Ave., Berkeley Heights, N. J.

Circle 651 on Page 19

Stainless-Steel Strip

Provides a guide to the correct selection of various stainless grades for specific applications. Data on the analyses, physical and mechanical properties, heat treating, and finishing of 19 stainless-steel types are provided, plus visual presentations of applications in the automotive, architectural, household, and other fields. General cleaning procedures for fabricated stainless products, and weight tables, are also included. 32 pages. Write on company letterhead to Superior Steel Div., Copperweld Steel Co., Carnegie, Pa.

Precision Clamps

Presents diagrams, specifications, and list prices for over 150 different types of miniature instrument clamps. Divided into ten clamp categories; all parts listed are available from stock in prototype and production quantities. Write on company letterhead to Sterling Instrument Div., Designatronics Inc., 5 Sintsink Drive, Port Washington, L. I., N. Y.

Silicone-Rubber Compounds

Discusses SE-5504 11 self-bonding, silicone-rubber compounds which afford primerless bonds to ferrous metals. Covers applications for the new materials, and includes several charts and tables showing typical properties. 4 pages. Write on company letterhead to Silicone Products Dept., General Electric Co., Waterford, N. Y.

NEW DESIGN

SAVES UP TO 20%



VIKING'S COMPLETE NEW LINE OF JACKETED STAINLESS STEEL* PUMPS

*Also other alloys—nickel, Monel, steel, Ni-Resist, etc.

Now you save money on *new* type stainless steel* Viking Pumps and still get the same rugged, heavy-duty service. The new, improved design makes it possible. All parts coming in contact with the material handled are stainless steel or other specified alloy—other parts are cast iron. Its unique design incorporates a jacket chamber around the back of the pump, around the mechanical seal or packing chamber and over the head of the pump. This chamber permits cooling or heating of the liquid being pumped.

Mounting dimensions remain the same as Viking's previous compact line of alloy heavy-duty pumps, and without increased size for jacketing.

Six sizes from 10 to 110 G.P.M. are available. Pumps operate at full speed handling light liquids—at reduced speeds for heavy, viscous liquids. Pumps suitable for pressures up to 50 P.S.I. handling non-lubricating liquids. Completely self priming with positive discharge.

For additional information, send today for folder SP 537H

50 YEARS

VIKING PUMP COMPANY

Cedar Falls, Iowa, U.S.A. In Canada, It's "Roto-King" Pumps

See Our Catalog In Sweet's Product Design File

(See this new line of pumps at Viking's booth #1071, 28th Exposition of Chemical Industries, Coliseum, New York, N.Y., November 27-December 1. Pumps available in February.)

Circle 341 on Page 19

New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Miniature Lamp

prevents complete failure of signalling function

Twin-filament miniature lamp is a signal or indicator lamp that signals the need for replacement. Lamp prevent complete failure of signalling function without warning. It is made with two filaments, one of which supplies the major portion of the light output, the other designed for long life. When the first filament burns out, the second still functions as an indicator lamp, but at a reduced candlepower output. Thus, while signalling, it simultaneously indicates the need for



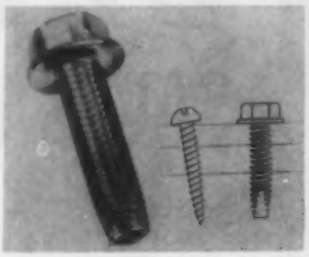
lamp replacement. Several sizes and designs are available. **Chicago Miniature Lamp Works**, Dept. MD-1, 1500 N. Ogden Ave., Chicago 10, Ill.

Circle 652 on Page 19

Square-Pointed Fastener

is thread-forming unit

Type S square-pointed fastener starts easily and drives straight. Fastener is available in all standard sizes, finishes and head styles, and is designed to do jobs done by a wide variety of screws. It uses the same lead holes as most standard thread-cutting and thread-forming screws. Unit provides a favorable torque ratio to prevent screws from stripping, and less possibility of head breaks. The thread-forming screw leaves no chips or ribbons to interfere with electrical contacts. It also maintains constant friction with the mating part to prevent loosening by vibration. **National Lock Co.**, Rockford, Ill.



Circle 653 on Page 19

Polyurethane Coatings

protect surfaces exposed to corrosion or hard use

Chemglaze coatings are true polyurethane coatings available as ready-to-use, one-part systems. High resistance to chemicals, solvents, and oils, as well as to dirt, impact, and ozone, makes them virtually immune to corrosion, deterioration, and wear. They retain surface gloss for a long time under abusive conditions. Coatings are available in hard versions for use over concrete, wood, metal, rigid plastics, glass, and in flexible versions for soft plastics, fabrics, leather, paper, rubber, and similar materials. Wide variety of colors and finishes assures durable, decorative surfaces. **Hughson Chemical Co., Div., Lord Mfg. Co.**, Erie, Pa.

Circle 654 on Page 19

Multiple Switch

is 6 or 12-station unit

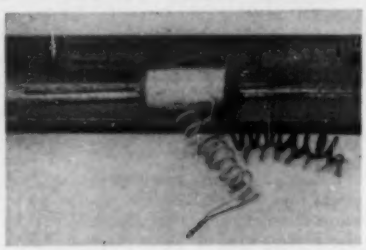
MLK multiple-station Littel Key switch consists of key switches supported by a common pivot rod of nickel-plated brass wire that depends on support between the switch frame and the mounting panel of the equipment on which it is used. It requires 2 3/32-in. depth behind the mounting panel. Assembly provides long spring-action life through the use of long springs without forms at the point of flexing. Unit offers multiplicity of circuits; three-position, lever-type switch or a two-position switch with momentary or locking action; choice of contacts. **Switchcraft Inc.**, 5555 N. Elston Ave., Chicago 30, Ill.

Circle 655 on Page 19

Small Relay

has speed of less than 0.8 millisec

New relay weighs only ¼ oz, and has nominal coil power of 0.06 w. Capacitance is less than 1 picofarad. Maximum contact rating is 4 w, and speed is 0.8 millisec. Unit is available with 6 v dc, 10-ma coil as illustrated. Contacts are hermetically sealed in inert gas.



New Products Inc., Box 10763, Cameron Village Station, Raleigh, N. C.

Circle 656 on Page 19

Right-Angle Gear Drive

has high horsepower and torque capacity

Miniature Float-A-Shaft 1:1 universal right-angle gear drive is self-aligning and infinitely adjustable,



Here is a major breakthrough in sealing air cylinders...

the new IPC ArchSeal*

REQUIRES NO MECHANICAL ASSIST. It floats . . . it's revolutionary . . . it's so simple in design and so reliable in service you'll wonder how you ever got along without it! IPC's custom engineered ArchSeal is just what the name implies . . . an arched design with *flexing* sides.

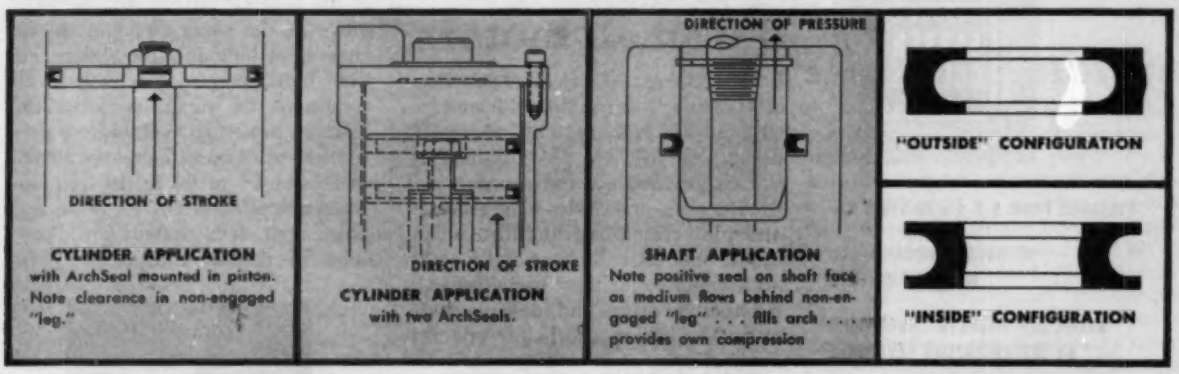
The far "leg" of this new seal moves *away* from the pressure source *instantly* . . . to provide positive sidewall sealing as the air medium flows around the non-contact leg and back-fills the hollow arch. Immediately . . . you get self compression on the *face* of the seal as the air pressure expands the face outward against either shaft or cylinder wall.

That's right! They're made for inside or outside sealing. Reverse the pressure or stroke . . . the seal reacts in the opposite direction with the same positive results!

Reliability? Many are performing perfectly now with over 20,000,000 cycles. Temperature range? From minus 30° up to 500° F.

Here's the *ideal* seal for air cylinders where no lubrication is possible. Here's the way to eliminate expensive assembly components of O-rings, U's or V's with their expanders, back-up rings, or washers. You don't need them! The ArchSeal solves the problem without extra frills.

Oh yes . . . it's an IPC "custom" product so we'll need details on your application. Don't hold back . . . the ArchSeal can be the answer for which you have been looking.



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PACKINGS
PRECISION MOLDING *Custom designed for your application*

INTERNATIONAL PACKINGS CORPORATION

Bristol, New Hampshire

*Patents and Trademark applied for.

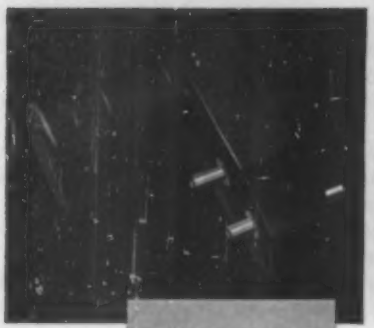
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Precision permanent magnet reversible motors...gearheads, blowers, and right-angle drives...for airborne and industrial applications









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STABILIZED MAGNETS...UNDAMAGED BY INSTANTANEOUS REVERSALS

SMOOTH RUNNING...LOW COGGING AND RIPPLE

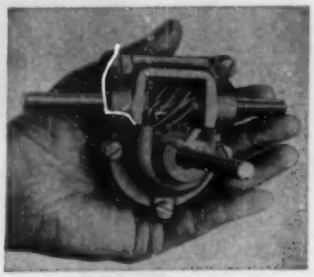
d-c small motors

Barber-Colman offers a large selection of compact, high-quality d-c motors with outputs up to 1/10 hp. Compact design . . . 1¼" to 1½" diameters. Various mountings and speeds . . . several sizes and styles of gearheads and blowers. Integral radio noise filters, magnetic brakes, and governors available for most basic designs. Right-angle drives and multiple-shaft outputs also available for special applications.

WRITE FOR NEW QUICK REFERENCE FILE on the complete line of Barber-Colman electrical components. Includes detailed specifications on a-c and d-c motors, tach generators, blowers, gearheads, relays.

BARBER-COLMAN COMPANY

Dept. W, 1873 Rock Street, Rockford, Illinois



with high horsepower and torque capacity. It utilizes hardened helical gears and an aluminum housing, and is for use where space is limited. Right and left-hand units are available for any requirement. Both can be used on the same drive train to operate drives in opposite directions at the same time. **Tol-O-Matic Inc.**, 246 Tenth Ave. S., Minneapolis, Minn.

Circle 657 on Page 19

Circulating-Ball Slide

supports weights in 1000-lb range

CB heavy-duty circulating-ball slide is available for electronic rack and cabinet packaging. Slide supports weights in the 1000-lb range and allows ease of sliding action because of two circulating-ball channels that extend completely around the top and bottom of the slide. As the chassis is pulled out of the cabinet, weight is evenly distributed over all of the bearing surface and the balls move in the same direction as the chassis, making for free sliding action. Unit operates effectively in all conditions of shock or vibration. Slide is available in standard sizes from 16 to 24 in. in 2-in. increments, and from 24 to 60 in. in 6-in. increments. Slide is 1⅛ in. wide and 3 in. high. It is coated with Poxylube 75 bonded film of molybde-



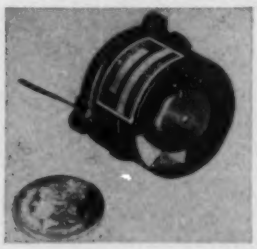
num disulfide which provides permanent, dry lubrication. Chassis-Trak Inc., 525 S. Webster St., Indianapolis 19, Ind.

Circle 658 on Page 19

Vaneaxial Blower

has maximum current of 1.15 amp at 53 cfm free-air delivery

VAX-2-MM vaneaxial blower has 2-in. diam, delivers 37 cfm at 1.5 in. water back pressure at 16,500 rpm using 26 v dc. Blower housing and propeller shroud, as well as propeller, are black anodized-aluminum castings. Weight is 5 oz. Units can be provided for voltages to 50 v dc. Mounting is made



by bolting to flange with three bolts. Maximum current is 1.15 amp at free-air delivery of 53 cfm. Globe Industries Inc., 1784 Stanley Ave., Dayton 4, Ohio.

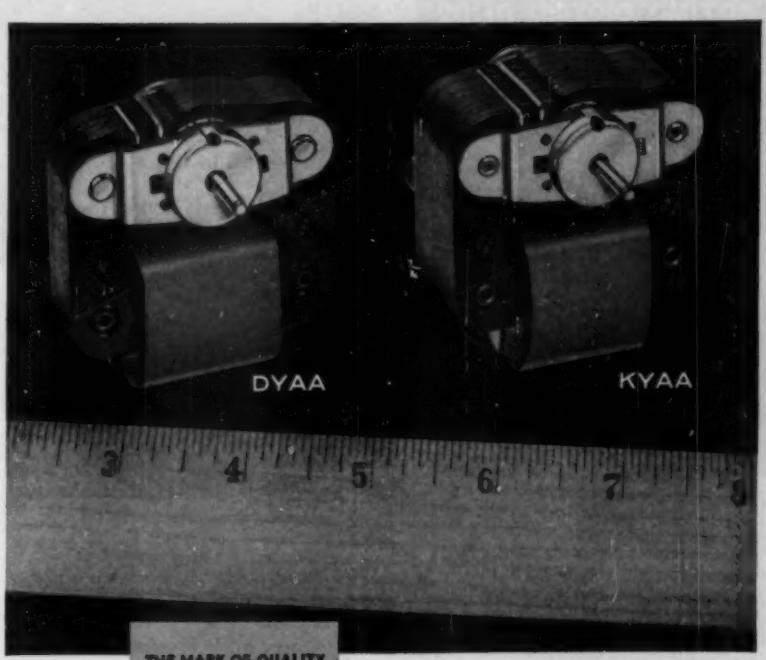
Circle 659 on Page 19

Printed-Circuit Board

requires no etching or other preparation

Fotoceram printed-circuit board allows making of prototype electronic devices by inserting and connecting components. Once a prototype proves successful, the matrix board can also be used for production. No etching or other preparation of the board is required. Board has a universal ring-and-dot pattern of metallized runs, pads, and through-plated holes on a base of Fotoceram glass-ceramic. Each corner of the board has a chassis mounting hole, and one end of the board is a 22-contact plug section. Board accepts all types of components, including transistors. Designed for use in ambient ter peratures to 250 C, board will not warp, bow, sag, swell, rot, delaminate, burn, or absorb

New Barber-Colman unidirectional, shaded pole a-c motors combine exceptionally small size and high torque ...ratings up to .005 hp



THE MARK OF QUALITY
BARBER COLMAN

COMPACT—APPROXIMATELY 2-1/4" SQUARE
STARTING TORQUES TO .19 LB-IN
RATINGS TO .001 HP WITH 5/16" STATOR
RATINGS TO .005 HP WITH 15/16" STATOR
ALIGNABLE SLEEVE BEARINGS
QUALITY GUARANTEED

a-c small motors

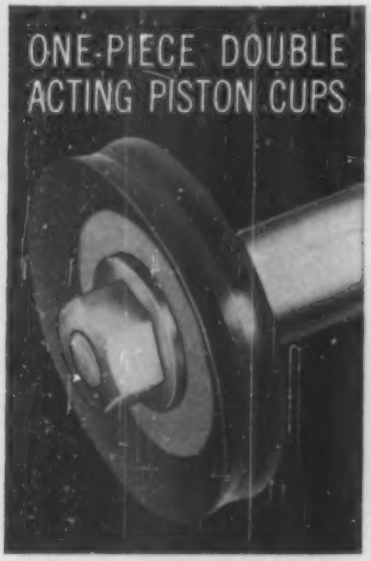
Small Barber-Colman types AYAA, DYAA and KYAA shaded pole motors are an ideal choice to power 2" - 6" diameter fans for deodorizers and electronic equipment . . . blowers . . . reroll chart drives . . . phonographs . . . gear trains . . . and other applications where physical size must be held to a minimum. High-quality construction throughout eliminates costly, bothersome maintenance . . . helps you build extra value into your product, at surprisingly low cost. Write for Bulletin F-10586.

THE WIDE LINE OF BARBER-COLMAN A-C MOTORS includes unidirectional, synchronous, and reversible types . . . with or without reduction gearing . . . open or enclosed. Stator and rotor sets also available.

BARBER-COLMAN COMPANY
Dept. W, 1273 Rock Street, Rockford, Illinois

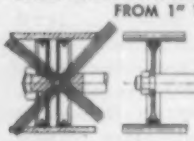
Circle 344 on Page 19

REDUCE COSTS,
IMPROVE PRODUCT
QUALITY!
use
CHICAGO-ALLIS



For cylinders, pumps, and valves . . . air, water, or oil. This is a piston type double-cup packing in a single unit . . . specially compounded rubber is bonded to metal disc of brass plated steel or solid brass. Lips are designed to maintain uniform pressure on the cylinder walls, insuring constant sealing action. Serving the same purpose as far more complicated and expensive pistons, Chicago-Allis piston cups are simple in design, economical, and provide long life and dependable service.

STOCK SIZES AVAILABLE FOR CYLINDERS FROM 1" TO 12"



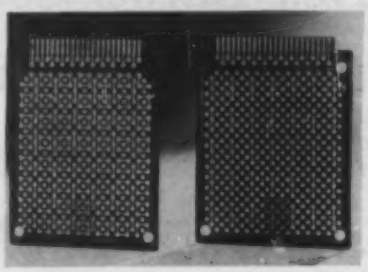
Simplify design... use one piston type cup that replaces piston and two seals



Write today for Bulletin 108

CHICAGO-ALLIS
MFG. CORP.
127 N. GREEN ST. CHICAGO 7, ILL.

Circle 345 on Page 19



moisture, oils, or organic solvents. Size is approximately 4½ x 5½ x 1/16-in. Corning Glass Works, Bradford, Pa.

Circle 660 on Page 19

Tantalum Capacitors

are available in working voltages of 6 to 125 v dc

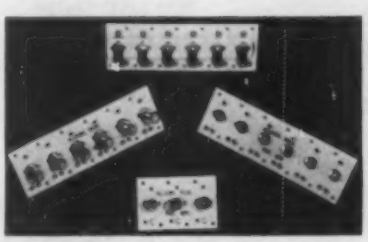
W-Type sintered anode, wet-slug tantalum capacitors provide high capacitance per unit volume. They are designed for use in temperatures from −55 to +85 C. Shorter and thicker than standard foil-type tantalum capacitors, they can be used where space limitations prevent use of the foil types. Capacitors are available in working voltages from 6 to 125 v dc with capacitances from 1.7 to 560 mf. Tansitor Electronics Inc., West Road, Bennington, Vt.

Circle 661 on Page 19

Multiple-Assembly Socket

has prewired common side

DL 100 multiple-assembly, printed-circuit, dial-light socket is for data computers, processing equipment, switchboards and automation applications. Printed-circuit assembly provides quick, easy, wiring with a minimum of handling and connection points. Common side is prewired, leaving only one lead per socket for hand wiring. Either vertical or horizontal reading is possible. Standard socket strips contain twelve ⅜-in. diam, bayonet-base



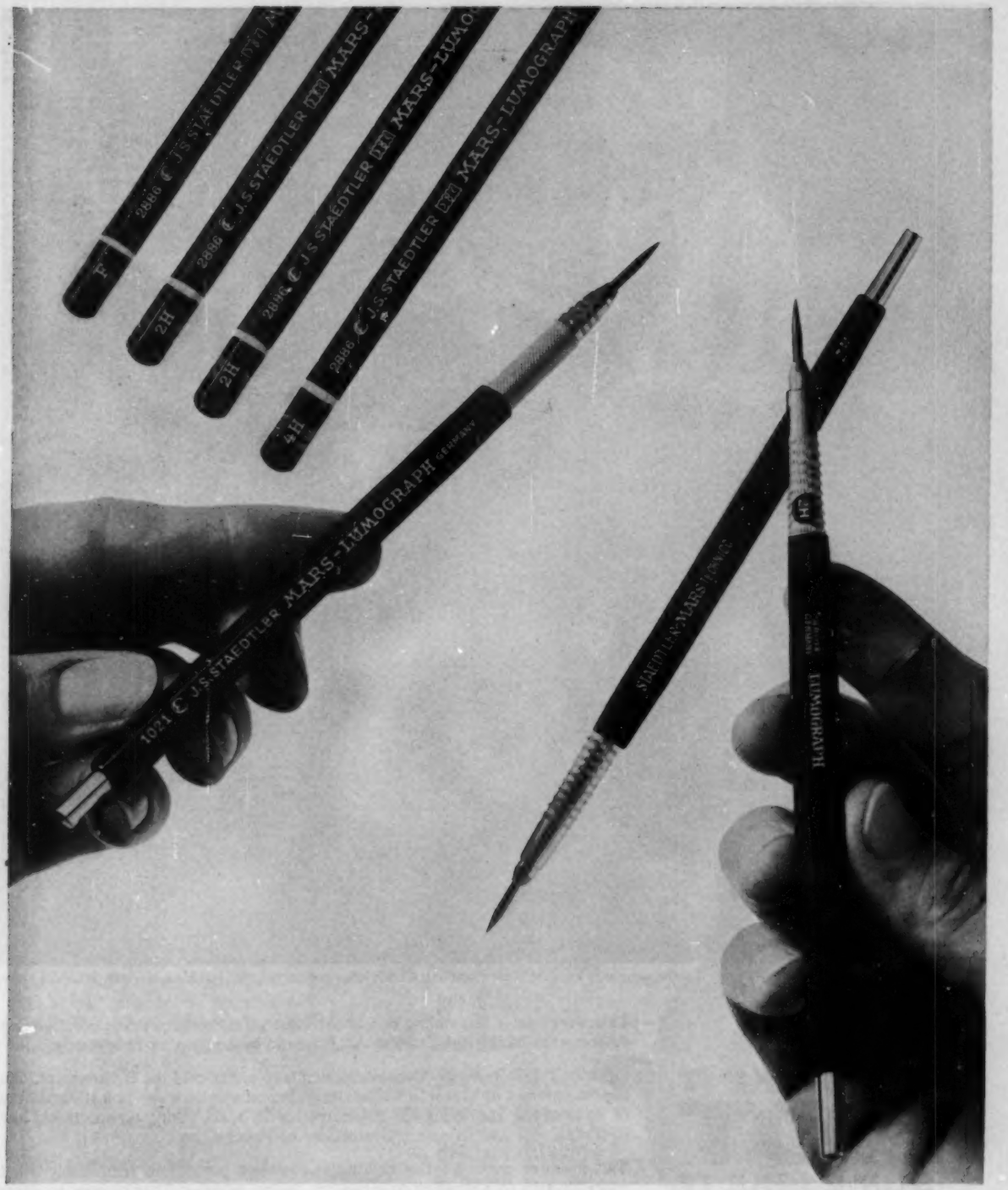
DORMEYER Dependability

Memo:-
TO ALL SOLENOID USERS!
Look for important announcement in next month's issue concerning completely new line of
DORMEYER SOLENOIDS!
MORE PULL!
COOLER!
QUIETER!

FROM
DORMEYER INDUSTRIES
3434 MILWAUKEE AVENUE
CHICAGO 41, ILLINOIS



Circle 346 on Page 19



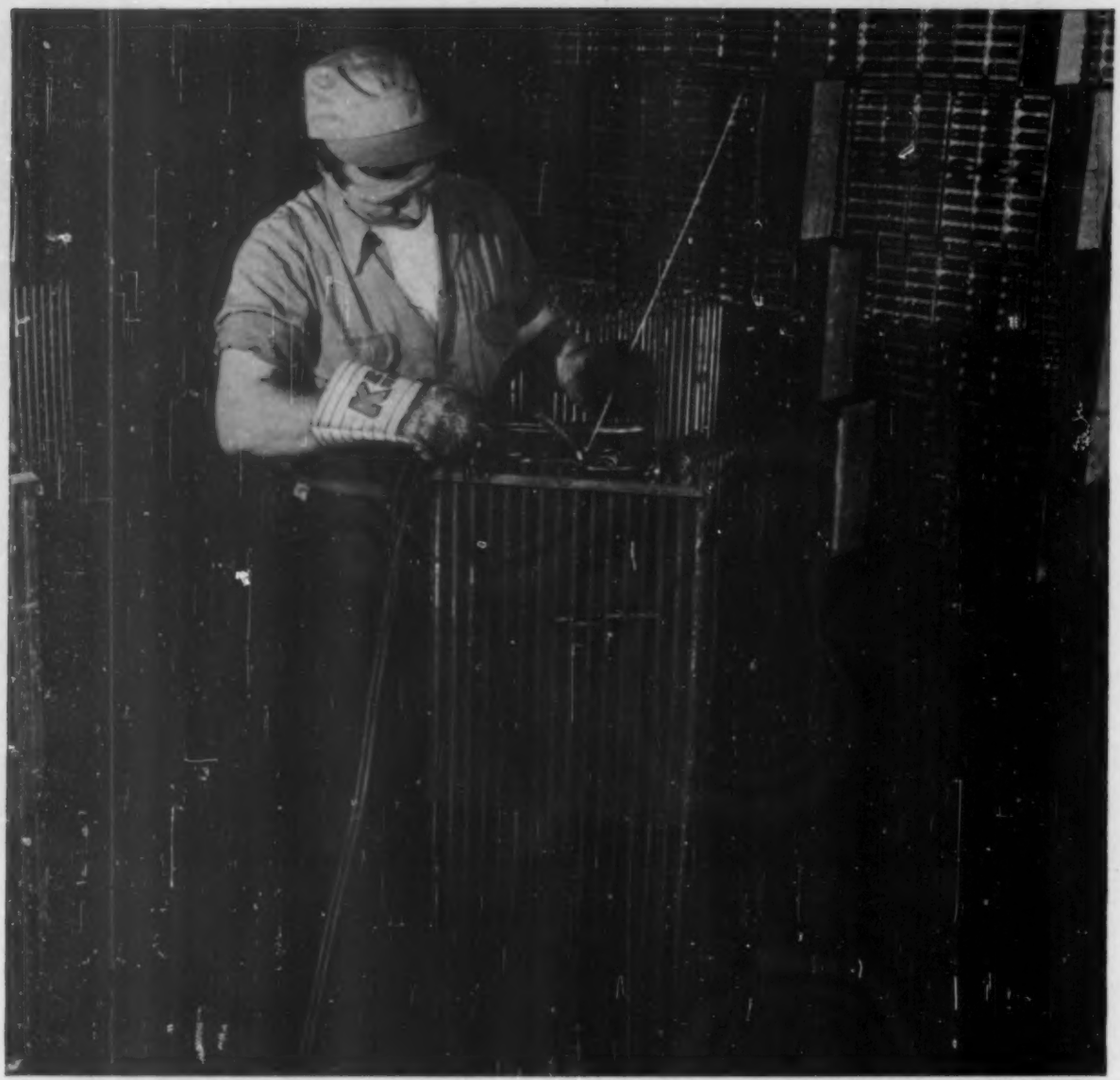
MARS vs MARS— You need neither lawyer nor judge. Let your own preference decide in favor of one MARS over another. For whether you pick one of the wood-cased Lumographs or one of the Technicos you'll be using the very finest.

Among the famous imported Mars drafting products are: the Mars-Technico push-button lead holders (with adjustable degree indicator*, with specific degree imprint*, the economy model*); Mars-Lumograph drawing leads, 18 degrees, EXB to 9H; Mars-Lumograph drawing pencils*, 19 degrees, EXEXB to 9H; Mars-Duralar pencils and leads for drafting on Mylar®-base drafting film —5 special degrees, K1 to K5; Mars-Duralar Technicos with adjustable Duralar degree indicator; Mars-Lumochrom colored drawing pencils, 24 shades. Also: Mars Pocket-Technico for field use; Mars pencil and lead sharpeners; Mars Non-Print pencils and leads; Mars-Duralar erasers. Mars products are available at better engineering and drafting material suppliers everywhere.

® T.M. for duPONT's Polyester film. *Shown.

the pencil that's as good as it looks **MARS**

J.S. STAEDTLER, INC.
HACKENSACK, NEW JERSEY



All return bends and many intercomponent connections on Fedders Heat Pump Air Conditioner are brazed with Handy & Harman SIL-FOS alloy.

SOME LIKE IT HOT SOME LIKE IT COLD

Versatile Fedders Heat Pump Air Conditioner Satisfies Both Needs According to Season... Brazed with SIL-FOS for Compactness, Strength and Reliability

This workman is assembling one of the most versatile temperature-conditioning devices ever made—the Fedders Adaptomatic heat pump air conditioner.

Utilizing the same thermodynamic principle to either cool the environment during the summer or heat it in winter, the Adaptomatic finds use in a wide variety of commercial and industrial structures for its space-saving compactness, low operating cost and its ease and economy of installation.

This machine packs a lot of heating and cooling power into remarkably small space, thanks to a number of ingenious design features. Thanks, too, to silver brazing. By making full use of Handy & Harman SIL-FOS in brazing the dozens of copper-to-copper joints in compressor, evaporator and condenser, and in joining major components, Fedders gives parts strength without bulk... gets leak-tight, ductile joints that withstand jars, vibration and thermal changes... makes every cubic inch count for the job it has to do.

The Handy & Harman family of brazing alloys and fluxes have a way of bringing out the best in any design—while saving production dollars. If you're not already familiar with them, our Bulletin 20 provides an extremely useful introduction. It's yours for the asking.

HANDY & HARMAN
850 Third Avenue, New York 22, N.Y.

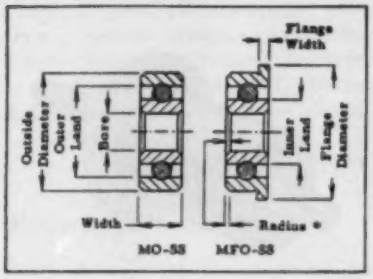
Circle 248 on Page 19

lamp sockets spaced on 5/8-in. centers. Each strip is completely insulated without using insulated shoulder washers. Sockets Div., Allegri-Tech Inc., 141 River Rd., Nutley 10, N. J.

Circle 662 on Page 19

O-Ring Bearings

in flanged and unflanged types need no lubrication



Inner and outer rings of flanged and unflanged O-ring bearings contain an O-ring which creates an antifriction sliding element, with sliding taking place between O-ring and races. Rings are AISI Type 440 C stainless steel; glass-filled Teflon or other low-friction plastic materials are used for the O-ring. Bearings require no lubrication or maintenance and are adaptable to vacuum applications. They are nonconductive and can be made nonmagnetic with 300 series stainless steel. Bearings are shock and vibration resistant, quiet, and have low coefficient of friction. They are made in Precision and Commercial grades. ODs range from 0.1562 to 0.6250 in. and bores from 0.0469 to 0.2500 in. Microtech Div., Federal-Mogul-Bower Bearings Inc., 1201 N. Arden Drive, El Monte, Calif.

Circle 663 on Page 19

Unidirectional Motor

offers ratings to 0.005 hp

Small, unidirectional, nongeared motor, designated YAA, has approximate dimensions of 2.5 x 2.25 in. It offers ratings to 0.005 hp, no-load speed of 3000-3300 rpm, starting torques to 0.19 lb-in., alignable sleeve bearings, and various mounting arrangements. Typical applications are fans for deodorizers and

and again... another NEW product from Stearns

...pace-setting pioneer in electro-magnetic clutches—brakes—clutch-brakes

4 "Packaged" Clutch-Brakes (Type SMCB)

- Pre-Assembled...
- Pre-Aligned...
- More Economical...
- Install Faster...
- Up To 150 Cycles per Minute...
- Speeds to 3600 RPM...
- Request New Product Preview 2-61-C For All The Data.

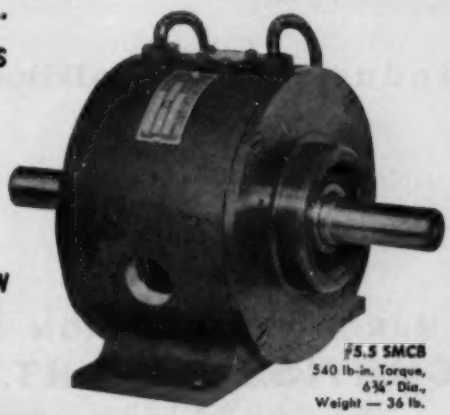


#3 SMCB
60 lb-in. Torque; 3 1/16" Dia.; Weight — 7.5 lb.

#2.2 SMCB
8 lb-in. Torque; 2 1/4" Dia.; Weight — 4 lb.



#5 SMCB
240 lb-in. Torque; 4 7/8" Dia.; Weight — 16 lb.

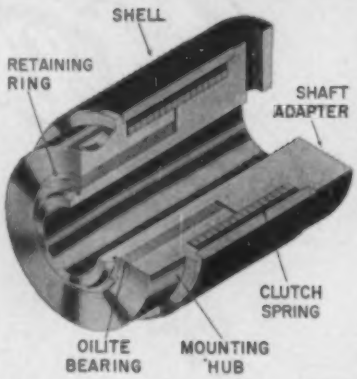
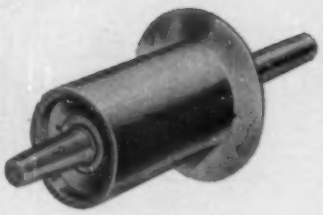


#5.5 SMCB
540 lb-in. Torque, 6 3/4" Dia., Weight — 36 lb.

Stearns ELECTRIC CORPORATION
120 NORTH BROADWAY • MILWAUKEE 2, WISCONSIN
The Complete Line of Electromagnetic Clutches — Brakes — Clutch-Brakes
SINCE 1917-THE CHOICE OF LEADING MOTOR AND MACHINERY MANUFACTURERS

Circle 349 on Page 19

Precisionspring CLUTCHES

LOW COST	LONG LIFE	SMALL SIZE
		
The basic cost of Curtiss-Wright clutches is lower than others of comparable size. They require only a small energizing force, so inexpensive actuation may be used. The clutch costs less — it may reduce the cost of other mechanism parts too.	Standard Curtiss-Wright clutches are available in torque capacities from 8 to 1250 lb./in. Other units custom designed to specification, for practically any braking or clutching problem. Transmitted torque is constant throughout life of the clutch.	Curtiss-Wright clutches are smaller than any other clutch of comparable torque rating. Per unit of transmitted torque they are lighter and more compact. Instantaneous, positive gripping action eliminates slippage, wear and lost cycling time.
EASY ACTUATION	**FLEXIBLE DESIGN**	**POSITIVE ACTION**

Industry's Most Diversified Line of Spring Clutches

MARQUETTE DIVISION
CURTISS-WRIGHT
CORPORATION

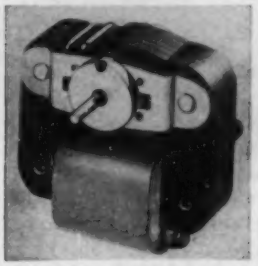
1145 GALEWOOD DRIVE
CLEVELAND 10, OHIO

Distributed in Canada by
Canadian Curtiss-Wright Ltd.
Toronto & Montreal, Canada

AD NO. 52-10

Curtiss-Wright clutches have proved their long life and dependable service in many diversified applications in a variety of industries. Compactly designed for instantaneous, positive action at very high speed without loss in efficiency. No slippage . . . no wear — low maintenance. Excellent for installation in inaccessible spots — need no lubrication and operate equally well in either an oil bath or dry.

A skilled staff of Curtiss-Wright engineers will help you pick the proper clutch for your application — or custom design a special clutch for the job. Write today for a complete catalog, or for consultation with a Marquette Division application engineer.



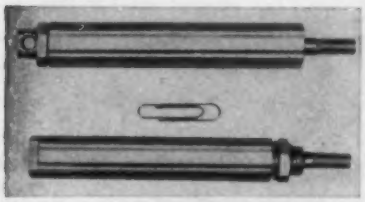
electronic equipment, blowers, reroll chart drives, phonographs, gear trains, electric erasers, and others where physical size must be kept to a minimum. Dept. 2411, Motors & Components Div., Barber-Colman Co., Rockford, Ill.

Circle 664 on Page 19

Miniature Cylinder

for up to 250 psi air and 2000 psi hydraulic

Heavy-duty, fine-pitch, screw-together, miniature double-acting and spring-return air-hydraulic cylinder has a 9/16-in. bore. Designed for working ranges to 250 psi air and 2000 psi hydraulic, cylinder is available in stud, clevis, and universal-mounting styles. Double-acting cylinders are furnished in six strokes from 1 to 6 in.; single acting (spring-return) units are available in 1, 2, and 3-in. strokes. Piston rods are ¼-in. stainless steel; rod extension



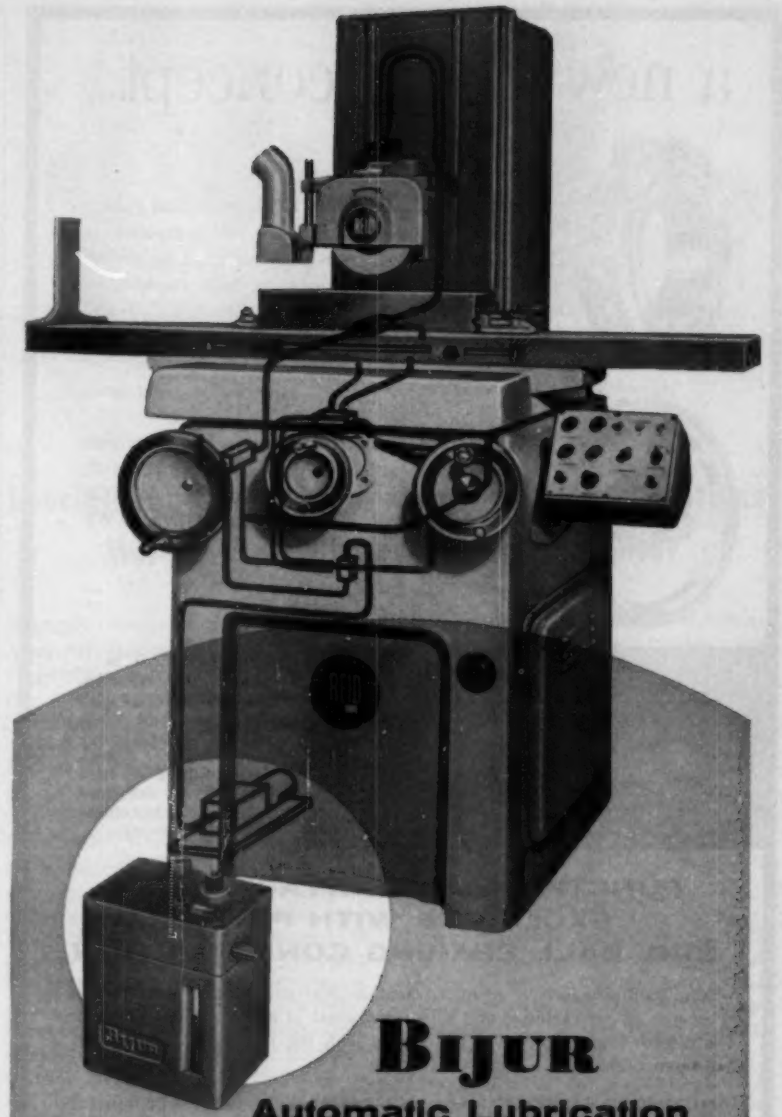
is ¾ in. threaded ¼-28 x ½ in. Ports are threaded 10-32. Clippard Instrument Laboratory Inc., 7390 Colerain Rd., Cincinnati 39, Ohio.

Circle 665 on Page 19

Liquid-Spring Shocks

are double acting

Double-acting, tension-compression Liquid-Spring Shoks absorb and store energy in both directions. Double-acting piston system uses the same liquid to provide identical or different energy in tension and



BIJUR

Automatic Lubrication Keeps Machines Humming

Your customers can get more production from your machines when they are equipped with Bijur Automatic Lubricating Systems because every bearing is metered the proper quantity of oil at predetermined intervals.

Bearing failures are eliminated. Downtime is reduced. Machine performance is improved.

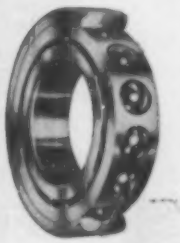
Unless you have already adapted Bijur as your automatic lubricating standard, why not let Bijur engineering help you in designing a system to meet your specific requirements? Write for literature and ask to talk to a Bijur sales engineer.

BIJUR LUBRICATING CORPORATION

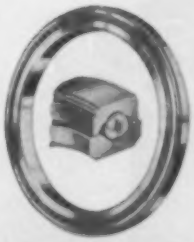
157 West Passaic Street • Rochelle Park, New Jersey

Pioneers in Automatic Lubrication

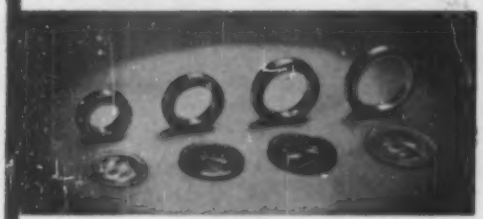
a new design concept...



HDR SERIES High precision radial ball bearings with maximum ball complements in deep groove races uninterrupted by filling slots or counterbore — extra high capacity — made in four metric series, in ABEC 3 and ABEC 5 precision grades.



T SERIES Thin-section, high precision radial ball bearings. Type TCR with maximum ball complement and retainer — Type TCF with full race ball complement — Type TWF with unique integral shield.



MIDGET T's Small, thin-section radial ball bearings with maximum ball complements and one-piece retainers — high concentration of load capacity in minimal space results in tremendous space savings.

FUNCTIONAL ADVANTAGES EXCLUSIVE WITH PATENTED SBB BALL BEARING CONSTRUCTION

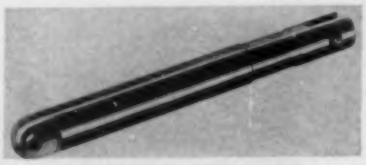
Split Ballbearings have many advantages over conventional ballbearings because of our exclusive and patented method of construction. The result is a new kind of precision ballbearing with the following superior performance abilities:

MORE LOAD CAPACITY — up to 56% more radial capacity than conventional Conrad-type bearings while maintaining full thrust capacity in either direction. **LONGER SERVICE LIFE** — up to 280% more life than conventional Conrad-type bearings, without sacrificing load capacity. **ONE-PIECE RETAINER** — strong, light, precision made. **SPACE SAVING** — more capacity in a given bearing envelope means smaller bearings may be used. **LOW TORQUE** — maximum ball complements and precision one-piece retainers provide better load distribution within the bearing, effectively reduce starting torque, and minimize running torque. **GREATER RIGIDITY, LESS DEFLECTION, INCREASED RESISTANCE TO SHOCK LOADS** — all these advantages derive from using maximum ball complements in deep groove bearings without filling notches or counterbored rings . . . possible only with Split's patented construction method. **INTEGRAL SHIELDS** — truly integral shields in thin-section bearings . . . no ring distortion. **SPECIAL DESIGNS** — Split Ballbearing's method of construction brings new solutions to difficult bearing problems. As a result, many of these incorporate special bearing designs. You are invited to consult with our Special Bearing Engineering Group for new approaches to your particularly difficult bearing problems.

split ballbearing

SBB DIVISION OF MPB INCORPORATED

LEBANON, NEW HAMPSHIRE



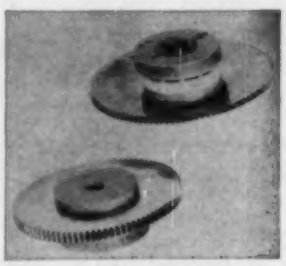
compression. Any desired shock or spring curve is available to meet design requirements. Shocks provide infinitely variable spring and/or dashpot energy capabilities from 50 to 250,000,000 in.-lb, controllable return velocities from milliseconds to days, minimum weight and space requirements, and high and low-temperature capabilities. Unit shown is 14¾ in. between hole centers and 1⅝ in. diam. **Taylor Devices Inc.**, 200 Michigan Ave., North Tonawanda, N. Y.

Circle 666 on Page 19

Miniature Slip Clutch

is adjustable from 0 to 50 oz-in. torque

Improved gear-type slip clutch consists of a stainless-steel spur gear, Delrin bearing and clutch plate, steel spring, and anodized-aluminum hub and clamp. Bearing and clutch plate provide smooth torque transmission with a minimum change from preset torque value. Clutch is adjustable from 0 to 50 oz-in. torque. Axial position of clamp



sets torque and locks unit to shaft. **Northfield Precision Instrument Corp.**, 4400 Austin Blvd., Island Park, L. I., N. Y.

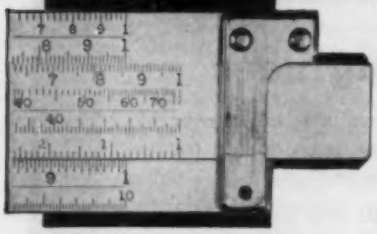
Circle 667 on Page 19

Printed Circuits

are miniature multilayered units

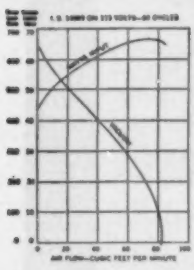
Encapsulayers are multilayered printed circuits, with layer-to-layer interconnection by means of land-

Fractional Horsepower Motors



Lamb® Helps You Select The Right Vacuum Cleaner Motor

9/16 HP, 5-11/16" fan case diameter



IS-14750 thru ventilated

APPLICATION: Domestic portable cleaners.

IS-14809 by-pass ventilated

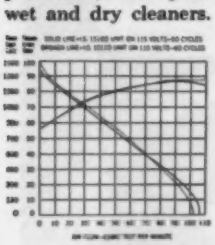
APPLICATION: Wet pick-up portable cleaners and central cleaning systems.

Service Life: Moderate
Cost: Low
Bulletins 101 & 201

NEW

1 HP, 7-3/16" fan case diameter

APPLICATION: Central vacuum systems in particular, also portable commercial wet and dry cleaners.



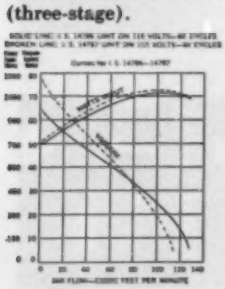
IS-15100 Diffused air discharge

IS-15110 Single air discharge

Service Life: Moderate
Cost: About twice cost of 9/16 HP
Bulletins 251 & 252

7/8 HP, 7-1/2" fan case diameter

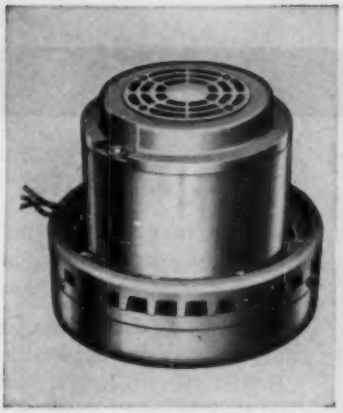
APPLICATION: Portable Heavy Duty Commercial Cleaners and Central Systems (three-stage).



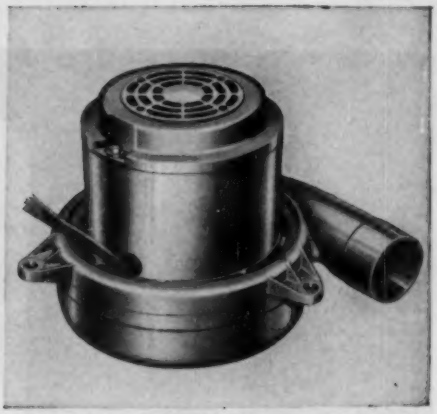
IS-14786 2-Stage

IS-14787 3-Stage

Service Life: Long
Cost: About 3 times cost of 9/16 HP
Bulletin 301



IS-15100 (Diffuser Discharge)



IS-15110 (Single Air Discharge)

Special Requirements of Central Vacuum Systems Met by New High Performance Motor

Existing vacuum motors have been designed to perform best when incorporated into portable vacuum cleaners of standard types and sizes. Such motors are built to produce highest efficiency under air flow conditions that exist in normal domestic and industrial cleaning service and where hoses are of normal length and diameter.

On special applications, like central vacuum cleaning systems that utilize extremely long cleaning hoses, and where tubing losses are present, a special motor is required. To meet this need, Lamb now offers a vacuum motor which will maintain a relatively high vacuum with a modest amount of air flow. The result: these motors operate at high efficiency in the high vacuum range without sacrificing air flow performance under low vacuum conditions.

INPUT – 10 AMPERES at 115 VOLTS

For economical, cleaner design, this rating at Underwriters' test point was selected as the input limit. This allows use of line cord not exceeding number 16 type SJ and control switches of 10 ampere rating.

NEW TAPERED BLADE DESIGN

On central systems which employ centrifugal dirt separation, a small amount of fine dirt and lint must pass through the fan and is discharged outside of the building. For maximum efficiency, this type of fan blade is designed with a long backward curving sweep which, however, may accumulate fine dirt due to centrifugal action. This dirt builds up to a point where starting acceleration dislodges dirt from one blade, resulting in unbalance, noise, and vibration. Special steep angle blades have been used but they also have serious performance limitations.

Lamb research has developed a moderately steep blade angle plus a tapered form. The result is a compromise that yields excellent performance and all but eliminates the dirt loading problem.

CHOICE OF AIR DISCHARGE SYSTEMS

Lint accumulation is minimized and high vacuum is improved in the IS-15110 with a single tangential discharge pipe. This allows for easy connection to a discharge piping system, if desired.

The IS-15100, by discharging air through slots in the fan case, results in better noise suppression.

FAN-END BEARING IS PROTECTED BY AIR COOLING

Motors in central vacuum systems are often required to operate for long periods of time under sealed conditions – which results in a high temperature rise in the fan system. In ordinary by-pass type motors, the electrical parts have a separate cooling system, but bearings in the adjacent fan case often become hot enough to destroy the lubricant. Early failures can and do result. Lamb's new motor prevents this by providing a unique ventilating system which directs cooling air over the fan-end bearing and protects the motor from harmful heat built-up within the fan case. For complete details, write to Lamb Electric Company, Kent, Ohio – ask for bulletins shown at left. *Also available – explosion-proof model. Ask for bulletin 401.*

Circle 353 on Page 19



Mr. Design Engineer

DIAMOND CHAIN CO., INC. makes available to you over 70 years of practical experience and know-how in the manufacture of power transmission products.

Products Manufactured: New No. 760 Catalog describes and illustrates finished steel ROLLER CHAIN, SPROCKETS, and FLEXIBLE SHAFT, "HI CAP" COUPLINGS. Write today for your copy!

Identification: Products are packaged either in clearly labeled cartons or transparent poly bags.

Availability: All products are readily available either from stocks in Indianapolis or from Distributors located throughout the U.S. who give emergency service on short notice.

Engineering Service: Technical engineering service is available on your request from the Indianapolis plant or the DIAMOND district office nearest to you.

Sales Terms: Standard business terms well established through use in American industry.

DIAMOND CHAIN COMPANY, INCORPORATED

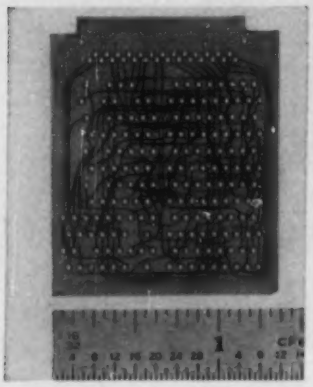
A Subsidiary of American Steel Foundries

Dept. 435 • 402 Kentucky Avenue, Indianapolis 4, Indiana

OFFICES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

DIAMOND ROLLER CHAINS ®

less plated-through holes. Circuits are designed in many layers and laminated together under heat and pressure to produce circuit panels with high system flexibility. Circuit shown measures 1.6 x 1.4 x 0.050 in. and has three circuit layers. There are 205 plated-through holes 0.013 in. diam. Hole-to-hole distances are 0.050 and 0.066 in., and conductor width is 0.010 in. Encap-



sulayers with up to six individual circuit layers are available. **Photocircuits Corp.**, Glen Cove, L. I., N. Y.

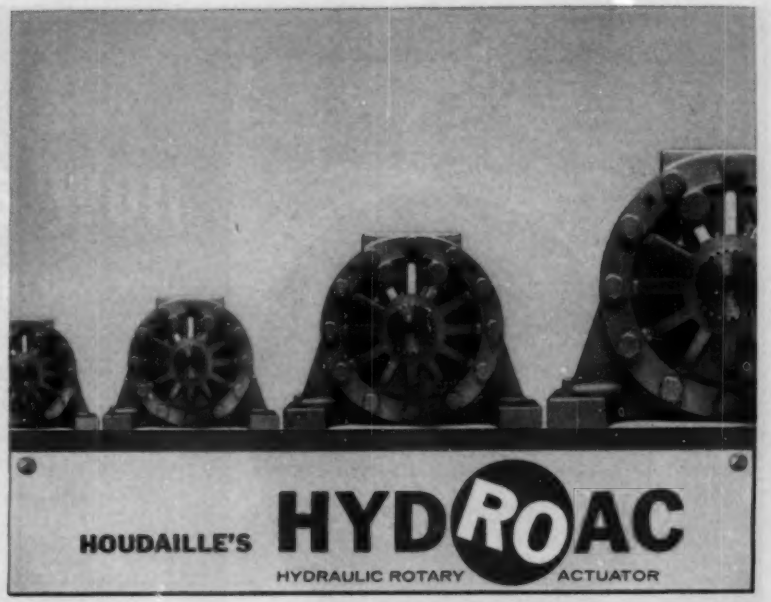
Circle 668 on Page 19

Right-Angle Valves

for operating pressures to 5000 psi

Type ECR right-angle valves are available for use as check or low-pressure relief valves. External cracking-pressure adjustment allows the valves to be adjusted quickly and easily while in operation. Removable end-cap assembly permits them to be cleaned or inspected without removal from the line. Valves have a one-piece, all steel, leakproof body and have a minimum of internal parts. They are furnished for operating pressures to 5000 psi and are available in ¼ to 1¼-in. sizes. Cracking pres-





Why is Hyd-Ro-Ac different from other Rotary Actuators?

Houdaille designed glass impregnated Teflon seals reduce break-out torque — prevent extrusion — improve efficiency. Pressurized O-Ring back up member insures positive seating *over the life of the unit* — reduces internal leakage to the lowest in the industry. That's why HydRoAc is the only commercial hydraulic rotary actuator with aircraft quality performance, available today in 4 sizes, 80 options right off the shelf.

HydRoAc offers an added FIRST in stock actuators — operating pressure to 3000 p. s. i. Our HydRoAc catalog will give you the full story. Send for it today.

.. Specialists in rotary type hydraulic equipment

Houdaille Industries, Inc.

Buffalo Hydraulics Division • Dept. B • 537 E. Delavan Ave., Buffalo 11, N. Y.

Circle 355 on Page 19



now available!

new high temperature alloy data

The complete, up-to-date story of Carpenter High Temperature Alloys—how they are helping designers and fabricators produce better, more dependable components for the high temperature power plants of today and tomorrow. Includes important technical data on properties and performance of Carpenter VACUMELTROL® (induction vacuum) and CONSUMET® (consumable electrode) alloys with helpful tips on alloy selection and fabrication.

An important addition to your high temperature files—68 pages, attractively bound in loose-leaf covers to accommodate new data as it is issued. Includes technical data on 23 Carpenter High Temperature Alloys, many described for the first time. **Write for your free copy today!** The Carpenter Steel Company, 120 W. Bern St., Reading, Pa.

Carpenter steel

you can make it ***consistently*** better with Carpenter Specialty Steels for specialists

The Carpenter Steel Company, Main Office and Mills, Reading, Pa.
Export Dept., Port Washington, N. Y.—"CARSTEELCO"
Alloy Tube Division, Union, N. J.
Webb Wire Division, North Brunswick, N. J.
Carpenter Steel of New England, Inc., Bridgeport, Conn.

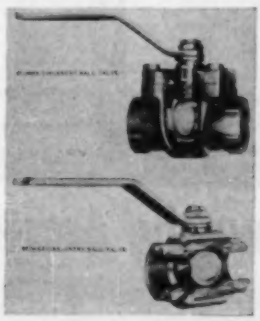
sures are adjustable from 50 to 150 psi. **Manatrol Corp.**, 2372 W. Seventh St., Cleveland 13, Ohio.

Circle 669 on Page 19

Ball Valves

for vacuum processing systems

Two new ball valves for service in vacuum-processing systems provide quick-opening, full conductance and minimum pressure drop, and tight-sealing shut-off in either direction. One style permits top-entry for fast, easy access and rapidly completed maintenance without disconnecting valve from line. The other, for line-entry, is shorter (end-to-end) and lower in over-all height than many



other valve types. Both types have double-gasket stem seals. Valves are available in sizes from ¼ to 3 in.; materials are carbon steel, stainless steel, or bronze. Both types are available with flanged or screwed ends. **F. J. Stokes Corp.**, 5500 Tabor Rd., Philadelphia 20, Pa.

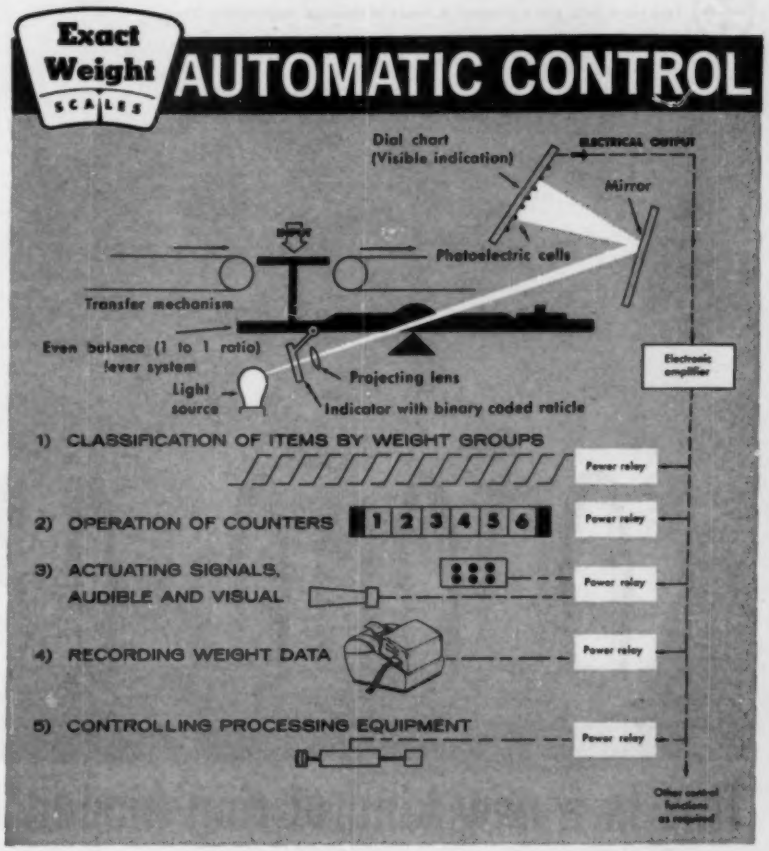
Circle 670 on Page 19

Pressure Switch

for pressures from 0.5 to 3000 psig

Pressure switch weighing 6 oz provides simple on-off control at a predetermined pressure. It operates at pressures from 0.5 to 3000 psig. Rated for more than 100,000 operations, it will work with both liquids and gases. Available in both aluminum and stainless steel, switch incorporates a diaphragm as its sensing element and a miniature snap-action switch as its actuating element, capable of switching up to 5 amp. Maximum burst pressure is 10,000 psig. Unit withstands shock

(Please turn to Page 264)



This weight-sensing principle may solve your design problem

If your product involves automatic control — processes, quality or costs — the Exact Weight principle of weighing or measurement of force may help solve your problem.

This precision weighing system, using photodiodes arranged to read deflections of a light beam, automatically supplies electrical output signals for a variety of sorting and control devices. Today, the Exact Weight principle is being used for positive control of basic operative functions in many types of automated machines including packaging, metalworking, textiles and plastics weighfeeders.

Send us your application requirements — or any weighing problem. Our engineers will gladly cooperate with you and make recommendations for the most economical solution.

NEW REFERENCE MANUAL
Here is a source of helpful design ideas showing various applications of weight sensing used in control functions. It is available free. Write for your copy today.

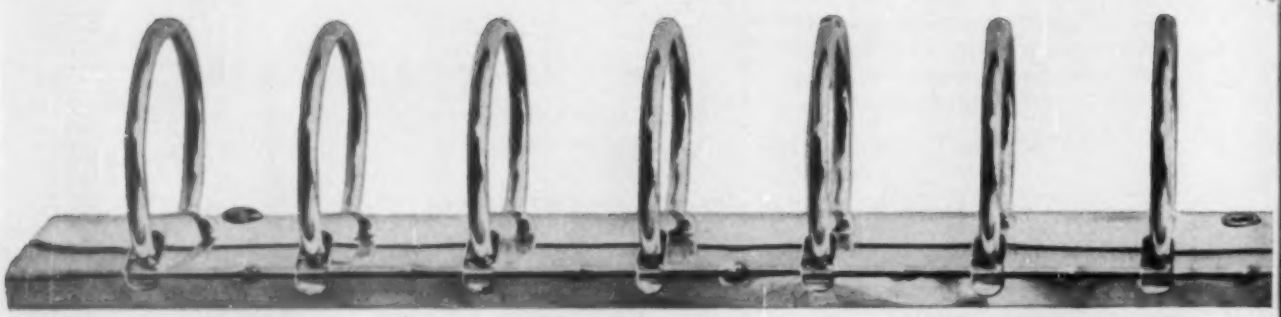


Exact Weight SCALES

THE EXACT WEIGHT SCALE CO.
925 W. FIFTH AVE., COLUMBUS 8, OHIO
In Canada: 5 Six Points Road, Toronto 18, Ont.

Circle 357 on Page 19

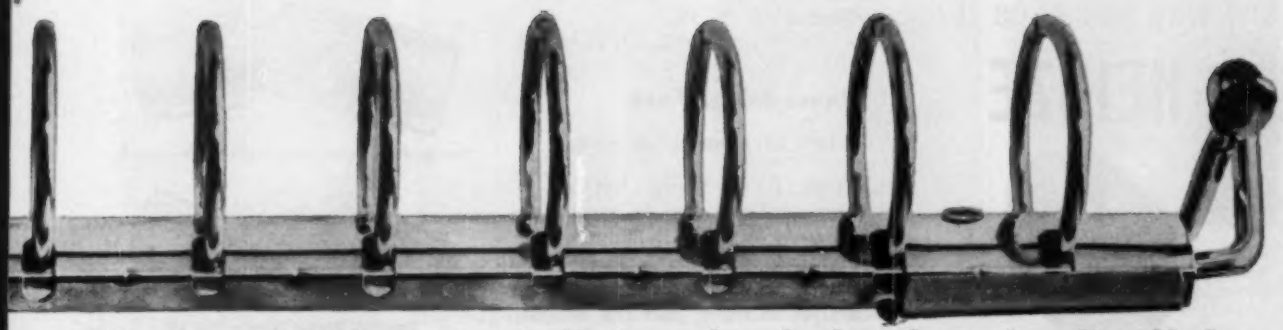
This mark tells you a product is made of modern, dependable Steel.



This is a new kind of ring binder. Below: the American



It opens, closes, and locks the rings, preventing spilled sheets. That's about all a ring binder does. And yet, coming up with the right wire for this binder was more than half a job. National Blank Book Company, Holyoke, Mass., asked our sales representative for an assist. He conferred with Charlie Canney—one of our top service metallurgists. **1.** Charlie met the people at National. **2.** He talked to their production people, came up with a profile of the wire they wanted. It had to have a uniform temper, the right temper for making the binder's snap-action ears, a clean, smooth surface for welding and plating, a temper which would vee-notch cleanly and still be rigid enough to stand distortion during production. **3.** Charlie took his problem back to our Worcester plant, talked it out with Clyde Westhaver, general foreman of cleaning, coating, heat treating; and Fred Brierly, product metallurgist. **4.** And then to the Metallograph—an instrument used in one of the many tests that determine the right properties. **5.** Charlie's report followed. **6.** Next, into limited production on the wire.



Steel and Wire specialists who helped make it click.



Wilfred Blades, quality control supervisor, and Francis Whalen, works metallurgist, kept close check on its condition during the initial draw. **7.** Before shipment, Arthur Weissinger and John Conrad, lab technicians, took stress-strain recordings **8.** The result: a ring binder that works just fine, and another satisfied customer. Call your American Steel and Wire salesman or nearest sales office the next time *you* need a metallurgical assist, or the best wire you can buy. American Steel and Wire, Rockefeller Building, Cleveland 13, Ohio.

Innovators in Wire

USS TRADEMARK

American Steel and Wire Division of United States Steel

Circle 358 on Page 19

put HEINZE in your designs



any way you slice it . . .

HEINZE



SMD MOTORS

are ideal for meat slicers

Heinze SMD Universal Motors are widely used in electric meat slicers because of their nigh running torque; small size in relation to horsepower (⅓); and because the shaft can be easily furnished with pinions and special worms to adapt it to a gear train. The SMD Motor is just one of a comprehensive line of compact Heinze Universal Motors for blenders, mixers, can openers, vacuum cleaners, pumps, toys, power tools and other applications. In addition to high starting and running torque, they are versatile to allow all types of mounting arrangements and modifications, are uniform in quality, keyed to high production, and are competitively priced.

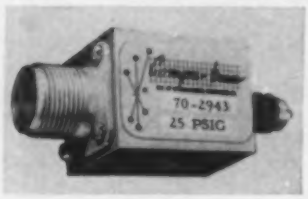
WRITE FOR COMPLETE CATALOG.

HEINZE ELECTRIC COMPANY
685 Lawrence St., Lowell, Mass.

SUB-FRACTIONAL HORSEPOWER MOTORS AND BLOWERS

Circle 359 on Page 19

(Continued from Page 261)



to 150 g and acceleration to 50 g. Vibration rating is 10 to 2000 cps, 20 g. It operates in a temperature range from −65 to +250 F. Control Components Div., International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

Circle 671 on Page 19

Silicone-Rubber Foam

cures at room temperature

Silastic RTV S-5370 low-density, silicone-rubber foam is supplied as a low-viscosity fluid; addition of a catalyst produces the foam. Expansion begins immediately after catalyst addition, and the reaction proceeds to completion in 4-5 min at room temperature. Foam can be handled immediately. When allowed to expand with restraint, material produces a foam with 10 per cent closed-cell structure and a density of 10 lb per ft. Foam is serviceable from −70 to +500 F, and has good electrical properties. Dow Corning Corp., Midland, Mich.



Circle 672 on Page 19

Insulated Stand-Off

has self-locking feature for attaching screw

Delrin insulated, self-clinching stand-off has high dielectric and tensile strength, and stability to creep or cold flow. Retainers are steel, stainless steel, or aluminum. Aluminum types can be mounted in

Lovejoy

Precision-Made Industrial
UNIVERSAL JOINTS

For Applications Up to 1750 RPM.

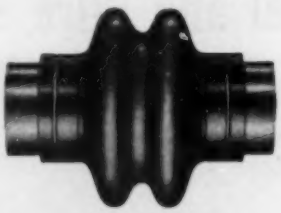
Here is a line of high quality universal joints for all industrial applications. Joints are available in an extremely wide range of sizes in each of the following general types:



Standard and Heavy Duty Single Joints—Type D



Standard Double Joints—Type DD



Boots for Joints
Also Special Joints Engineered to Order

- .35 to 190. at 100 RPM.
- Standard joints operate at speeds up to 1500 rpm. and heavy duty to 1750 rpm.
- Single joints operate through a full working angle of 40° and double joints 80°
- Made of case-hardened fine alloy steels for light weight and exceptional durability
- Boot provides an effective means of proper lubrication for heavy load, high speed and high heat applications... eliminates dust . . . can be removed and repacked in field

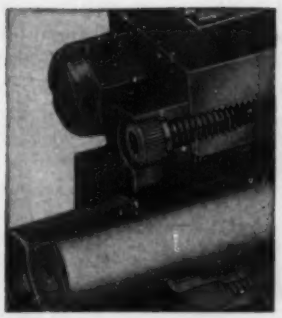
For detailed information on complete line ask for Bulletin D-61 on company letterhead. Also request recommendation for your application.

Lovejoy FIRST NAME IN UNIVERSAL JOINTS

LOVEJOY FLEXIBLE COUPLING CO.
4818 W. Lake Street • Chicago 44, Illinois

Please direct inquiries to advertiser, mentioning MACHINE DESIGN

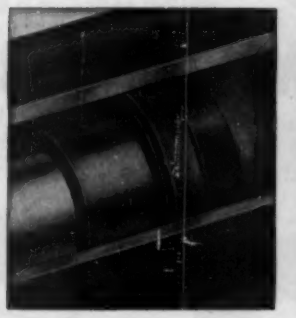
Do the cylinders you buy include these quality features?



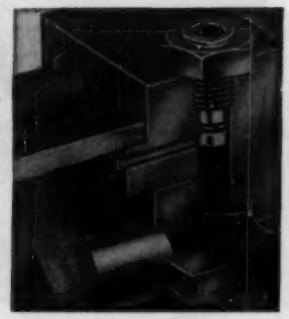
ROD GLAND—Easily removed. No need to loosen tie rods. Cuts maintenance time in half. Phenolic bearing insert will not score rod. Cuts replacement cost to a minimum.



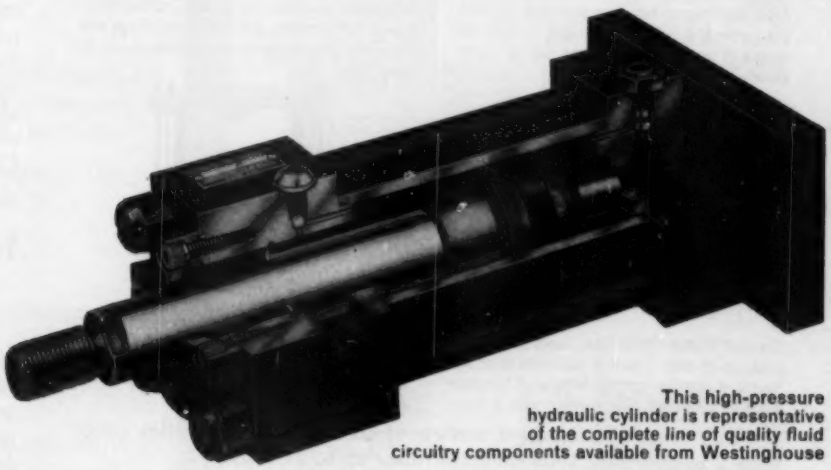
ROD PACKING—Interlocking multiple lip seals require no adjustments; remain flexible under fluid pressure. Wear compensating function eliminates frequent replacement.



PISTON—Phenolic piston will not score tube. Packing cups used for proven long life and seal. Cups are easily replaced. Piston positively locked to rod.



CUSHION—Minimum clearance between piston and Meehanite Bushing combined with micrometer metering gives top cushioning efficiency and a wide adjusting range.



This high-pressure hydraulic cylinder is representative of the complete line of quality fluid circuitry components available from Westinghouse

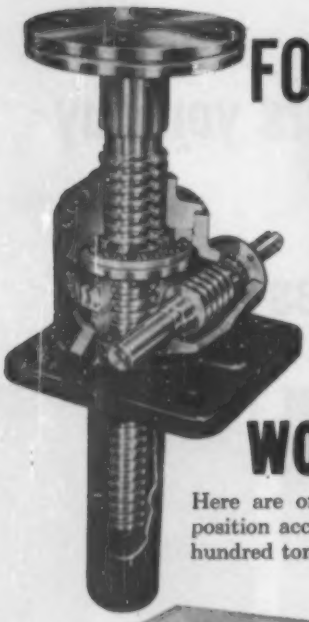
if not, the chances are, your maintenance costs are higher than necessary. For more information about Quality Fluid Circuitry Controls for trouble-free automation, ask for Catalog A3-56.00.

See the Yellow Pages under Cylinders for the Name of Your Local Distributor, or refer to Sweet's Catalog, Product Design File.

WESTINGHOUSE AIR BRAKE COMPANY

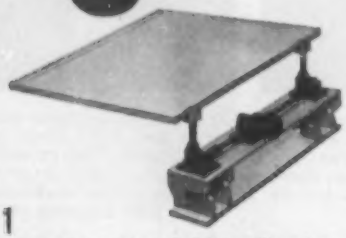
INDUSTRIAL PRODUCTS DIVISION, WILMERDING, PENNSYLVANIA

Circle 360 on Page 19



FOR ACCURATE MOVEMENT OF LOADS...USE DUFF-NORTON WORM GEAR JACKS

Here are only four examples of the many ways to position accurately loads weighing as much as several hundred tons with Duff-Norton Worm Gear Jacks.



1

An application with two Duff-Norton Worm Gear Jacks mounted on swivel subbase and each lifting screw end fastened to hinged member by means of clevis and pin. Jacks may be motor driven or manually operated.



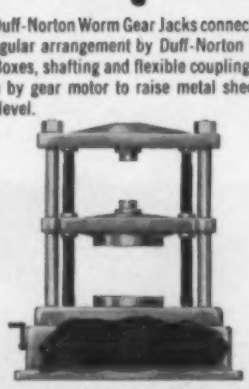
2

Four Duff-Norton Worm Gear Jacks connected in rectangular arrangement by Duff-Norton Mitre Gear Boxes, shafting and flexible couplings and driven by gear motor to raise metal sheets to press level.



3

Six Duff-Norton Worm Gear Jacks as used on pipe-cut-off and threading machines to adjust height of machine spindle to level of conveyor table to compensate for various sizes of pipe.



4

Platen pressure obtained positively and uniformly by two Duff-Norton Worm Gear Jacks with rotating screws.

There are eight standard models of these jacks—capacities range from 2 to 100 tons, with standard raises up to 24 inches.

For engineering drawings of standard jacks, mitre gear boxes and more examples of how Duff-Norton Worm Gear Jacks are used for accurate movement of loads, write for Bulletin AD-66a-V.

DUFF-NORTON JACKS

DUFF-NORTON COMPANY

Four Gateway Center, Pittsburgh 22, Pennsylvania

The Canadian Duff-Norton Co., Ltd., Toronto 6, Ontario

DUFF-NORTON JACKS
Ratchet • Screw
Hydraulic • Worm Gear

DUFF-NORTON

COFFING HOISTS
Ratchet Lever • Air
Hand Chain • Electric

Circle 361 on Page 19



materials having a hardness of Rockwell B 50 or less, steel and stainless-steel types in materials with hardness of B 70 or less. Stand-off has a self-locking feature for the attaching screw. It is available in lengths from ½ to 2 in., thread size 6-32. **Spyraflo Inc.**, Drawer E, Miami 64, Fla.

Circle 673 on Page 19

Roller Chain

is self-lubricating

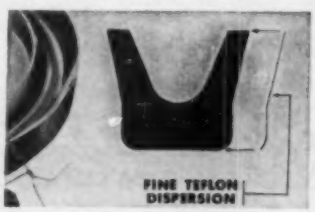
Rex Redi-Lube roller chain is available for drives and conveyors that cannot be lubricated regularly. Self-lubricating feature is achieved by use of a heavy, oil-impregnated, sintered-steel bushing that replaces roller and bushing of standard roller chain. Sintered bushing allows "self-feed" lubrication between bushings, pin, and sprocket teeth, assuring constant protection against corrosion, abrasion, and friction. **Chain Belt Co.**, Milwaukee 1, Wis.

Circle 674 on Page 19

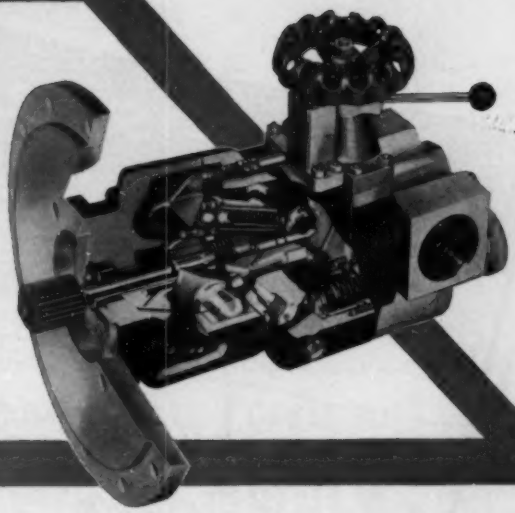
Teflon-Coated Seals

reduce breakout and running friction

Low-friction seals for dynamic applications are coated with a smooth, even dispersion of Teflon, applied on the outer seal wall only, reducing breakout and running friction and increasing the life and durability of the seal. Coefficient of friction is between 0.05 and 0.07 in. Teflon coated O-rings, V-rings, and U-cups combine the self-lubricating,



Nine piston, variable volume, pressure compensated type IA-38-9 pump, designed for use on Ground Support Equipment.



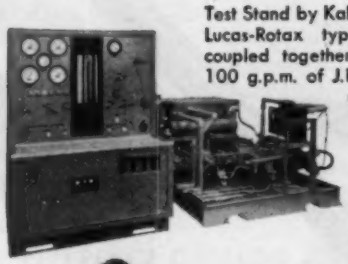
VERSATILITY-PROVEN *lightweight hydraulic* PUMPS AND MOTORS

Well known equipment manufacturers are specifying Lucas-Rotax hydraulic pumps and motors because they offer

- size and weight advantages in the 4 to 104 g.p.m. flow range
- pressures up to 5000 p.s.i.
- low noise level
- other attractive design features

Lucas-Rotax provides full engineering, sales and service throughout North America.

Your hydraulic requirements will be met by contacting Lucas-Rotax Limited, Toronto.



Test Stand by Kahn Company. Three Lucas-Rotax type IP-525 pumps coupled together provide flow of 100 g.p.m. of J.P.4 fuel for testing aircraft equipment.



Marine winches by Timberland-Ellicott are powered by Lucas-Rotax pumps and motors.



Two IA-38 pumps are incorporated in the portable Test Stand by Consolidated Diesel for use in checking out hydraulic system components on fighter aircraft at 5,000 p.s.i.

products of creative engineering by

LUCAS-ROTAX LIMITED

2200 EGLINTON AVE. EAST, TORONTO, ONTARIO.
POSTAL ADDRESS: BOX 115, STATION H, TORONTO 13.

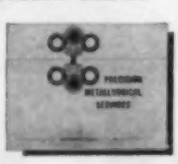
6102



"We needed a special magnetic 78½% nickel alloy in .234" ± .003" diam. rod stock and .042" x 5/16" x 4' strips. We got it from Hamilton."

says Robert Troxell, Relay Engineer, Cook Electric Company, Chicago, Illinois

PRECISION IS OUR PROVINCE. Working to minimum thickness of .00008", widths of ½", Hamilton can supply you with foil or strip—rod or wire—of virtually any alloy in production quantities. Our full-scale, completely-integrated facilities and engineering talent in this field permit absolute quality control from melt to finish. Thanks to these capabilities . . . a familiarity with precision work inherited from Hamilton's watchmaking background . . . experience with ultra-thin foils unmatched anywhere in the world . . . we offer you precision metals to meet your exact property and delivery requirements. We guarantee our product. Call us.



For additional information on Hamilton's facilities and capabilities, send for free booklet, "Precision Metallurgical Services." Write Dept. 3411, Metals and Electronics Div., Hamilton Watch Co., Lancaster, Penna.

HAMILTON WATCH COMPANY

Metals and Electronics Division, Lancaster, Penna.

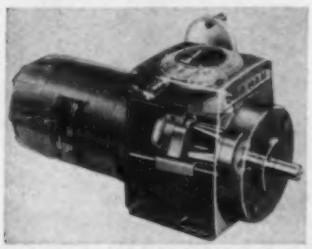
long-wearing properties of Teflon with the flexibility and versatility of the molded seal. Seals East Orange Inc., 393 Central Ave., East Orange, N. J.

Circle 675 on Page 19

Adjustable-Speed Transmissions

in sizes from 1/6 to 1½ hp

Redesigned metallic-traction, adjustable-speed transmissions provide speeds from any desired maximum down to zero and into reverse. Accuracy of speed holding and resetting over the entire range is accomplished, and speeds can be changed with the transmission either running or stationary. Features include built-in overload protection, one-piece housing design, unitized control assembly, new gear-tooth form,



new speed control stops, and new dial and handle which provide micrometer speed adjustment. Transmissions are available in sizes from 1/6 to 1½ hp, with or without motor and with or without built-in gear reduction or step up. Remote and automatic controls—mechanical, pneumatic, and electric—can be furnished. Graham Transmissions Inc., Menomonee Falls, Wis.

Circle 676 on Page 19

Limited-Rotation Motors

in Size 15 and Size 23 units

Series 90 limited-rotation motors are high-efficiency, current-to-torque transducers which have no wiping contacts. Angular rotation limits can be varied ±5 to ±25 deg from central position. Units are available in flange or front-face-type mounting for clamps or screws. Present units range from 0.1 oz-in. for Size 15 motor to 2 oz-in. for Size 23. Motors are useful in ultra-low-friction, direct-drive instrument and control applications. Excitation



Circle 364 on Page 19



coils are wound for ac, dc, or pulse-train operation. **Power-Tronic Systems Inc.**, Pine Court, New Rochelle, N. Y.

Circle 677 on Page 19

Dip-Coating Compounds

for plastics, ceramic, metal parts

One-component, dip-coating compounds for electrical components and metal hardware are known as conformable coatings. They are capable of build-up over plastics, ceramic, and metal parts by a dipping process which provides uniform coatings to thicknesses of approximately 1/32 in. No solvents are used in the coatings, although they are fluid and capable of many months' storage at room temperature. Baking at 300 F converts them to tough, semirigid materials with good adhesion and thermal-shock resistance. Epocast H-1780 is a dark-colored, low-viscosity grade capable of penetrating between fine electrical wires or into porous-metal castings to develop a smooth, uniform coating on metal surfaces. Heavier, reddish-brown, conformable coating, Epocast H-1724, encapsulates the components in protective blanket. **Furane Plastics Inc.**, 4516 Brazil St., Los Angeles 39, Calif.

Circle 678 on Page 19

DC Motor

for use under stalled condition

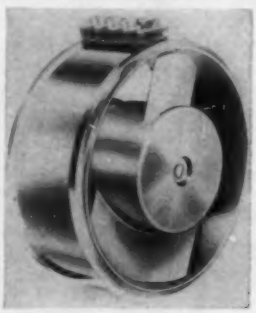
Model 4026-4 high-temperature, dc precision motor is available for computer drives. Motor is for use where operation is almost entirely under a stalled condition. Motor operates on an input voltage of 50 v. Output is rated at 500 oz-in. torque at zero rpm, and a no-load speed of 1500 rpm. Length of this model is 8 in., diam, 4 in. Other 40 Frame dc motors are available with power to 1 hp, input ratings to 115 v, and speeds to 12,000 rpm. **Eicor Div., Indiana General Corp.**, 517 W. Walnut St., Oglesby, Ill.

Circle 679 on Page 19

Tubeaxial Fan

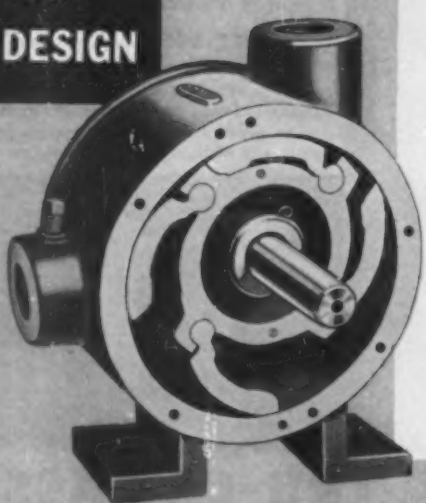
is 1¼ in. thick

IMCool tubeaxial fan is available for use in missile, aircraft, and ground electronic applications where high cooling capacity, size, and weight are primary considerations.



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with the Exclusive
HINGED VANE DESIGN

WEAR-FREE! CARE-FREE! REPAIR-FREE!



• The simplified Leiman hinged vane design provides larger air space, higher capacity—permits use of smaller pumps, slower speeds, lower horsepower. Every pump rigidly test-run before shipment. Specify Leiman Air Pumps for your vacuum, suction or pressure operations for lifetime dependability. Consult Leiman engineers on any application.

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Practically take care of themselves

Self-honing surfaces. Curved cast iron vanes rotating against cast iron cylinder walls hone wear surfaces to a hard, glassy smoothness. Provides continuous leak-proof seal and low-friction operation.

Self-renewing vanes. Cast iron vanes take up their own negligible wear. No composition tips to wear and renew. Provides years of new-pump efficiency.

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LEIMAN BROS., INC.
158 Christie St., Newark 5, N. J.
Established 1889

LEIMAN Rotary Positive AIR PUMPS
Vacuum to 29.9" Hg. Pressure to 20 p.s.i.g. Volume to 162 c.f.m.

Circle 365 on Page 19

WANTED

the toughest wear problem known for



CARMET CARBIDE

• the hardest metal known •

*****If you've got a real wear problem, it's time you take a long, hard look at Carmet Cemented Carbides . . . and how they can extend operational life and reduce costs.

Carmet Cemented Carbides possess the perfect combination of extreme hardness, strength, and abrasion resistance for the battering that wear parts must take . . . the rubbing, scrubbing, sliding, and scraping.

Carmet Cemented Carbides have a compressive strength higher than any metal or alloy . . . cast, rolled, or forged. They are the hardest man-made metal . . . next to a diamond in hardness, yet far tougher . . . three times stiffer than steel, and up to 100 times more abrasion resistant.

And you can put this hardness and wear resistance where it will do the most good. Carmet wear parts can be made in practically any shape . . . adapted to any function.

For all the facts on carbide wear parts, get Carmet's new booklet on design for wear resistance. It's packed with charts, graphs, case histories, and special design criteria for top wear parts performance. Ask your local A-L representative for a copy, or write: *Allegheny Ludlum Steel Corporation, Carmet Division, Oliver Building, Pittsburgh 22, Pennsylvania. Address Dept. MD-11.*

1003

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SPHERICAL BEARINGS & ROD ENDS

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WRITE FOR CATALOG 560

SPHERCO

A PRODUCT OF SEALMASTER BEARING DIVISION STEPHENS-ADAMSON MFG. CO.

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Circle 367 on Page 19

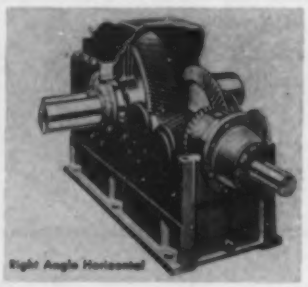
Unit is 1¼ in. thick, has 3 1/16-in. diam, and delivers 110 cfm at 50,000 ft. Input is 200 v, three phase, 400 cps. Rated for continuous duty, fan incorporates large-diameter bearings for long life and high reliability. The unit is supplied with a compact, screw-type terminal and servo-clamp mount. **Eastern Div., IMC Magnetics Corp.,** 570 Main St., Westbury, L. I., N. Y.

Circle 680 on Page 19

Speed Reducers

in 22 standard horizontal units

Two series of horizontal speed reducers are parallel shaft (Type Y) with ratios of 1.84:1 to 292:1, and right angle (Type YB) with ratios of 5.06:1 to 1207:1. Capacity ranges from 9000 to 1,570,000 lb-in. torque, in standard units with 22 standard sizes for each type. Gears are single helical with deep, high-pressure-angle tooth form for high capacity and strength. Heavy-duty, double-ended shafts can be turned 180 deg for double gear life. **Falk Corp.,** Box 492, Milwaukee 1, Wis.



Circle 681 on Page 19

Ceramic-Disc Capacitors

for operating temperatures from −30 to +85 C

Transcap ceramic disc capacitors have 0.05, 0.1, and 0.2-mfd capacitance, 25 v dcw, capacitance tolerance of +80, −20 per cent, and an operating temperature range of −30 to +85 C. Style 5855, the 0.05-mfd value, has maximum diameter of 0.437 in., maximum thickness of 0.156 in., and lead spacing of 0.250 in. Style 5815 is available in 0.1 or 0.2 mfd. Maximum diameter for both capacitances is 0.593 in., and

A RELIABLE PLUG-IN 25 AMP RELAY



More compact than most 10 amp relays

With "Diamond H" Series W dpdt relays you can fit as many as fourteen 25-amp circuits into a space measuring only 1⅜" x 1⅞" x 11⅛"!

Easy to install or remove—Spade terminals for socket or quick-disconnect installation. Solder terminals available.

Long, trouble-free service—Simple, functional construction with oversized solid silver contacts and contact bar assure long-time, dependable switching. Series W relays have given well over a million cycles at a 15-amp load.

SPECIFICATIONS

CONTACTS:
Arrangement—dpdt, double break, double make. Other arrangements and sequences.
Load—25 amp resistive, 120 or 240 V a-c
25 amp ind., 120 V a-c (75% p.f.)
12½ amp ind., 240 V a-c (75% p.f.)
1 hp 120 V a-c, 2 hp 240 V a-c
25 amp resistive 28 V d-c

MOUNTING: Panel, side or socket

DIMENSIONS: 1⅜ x 1⅜ x 1⅞ inches.

U/L APPROVAL: U/L File 31481

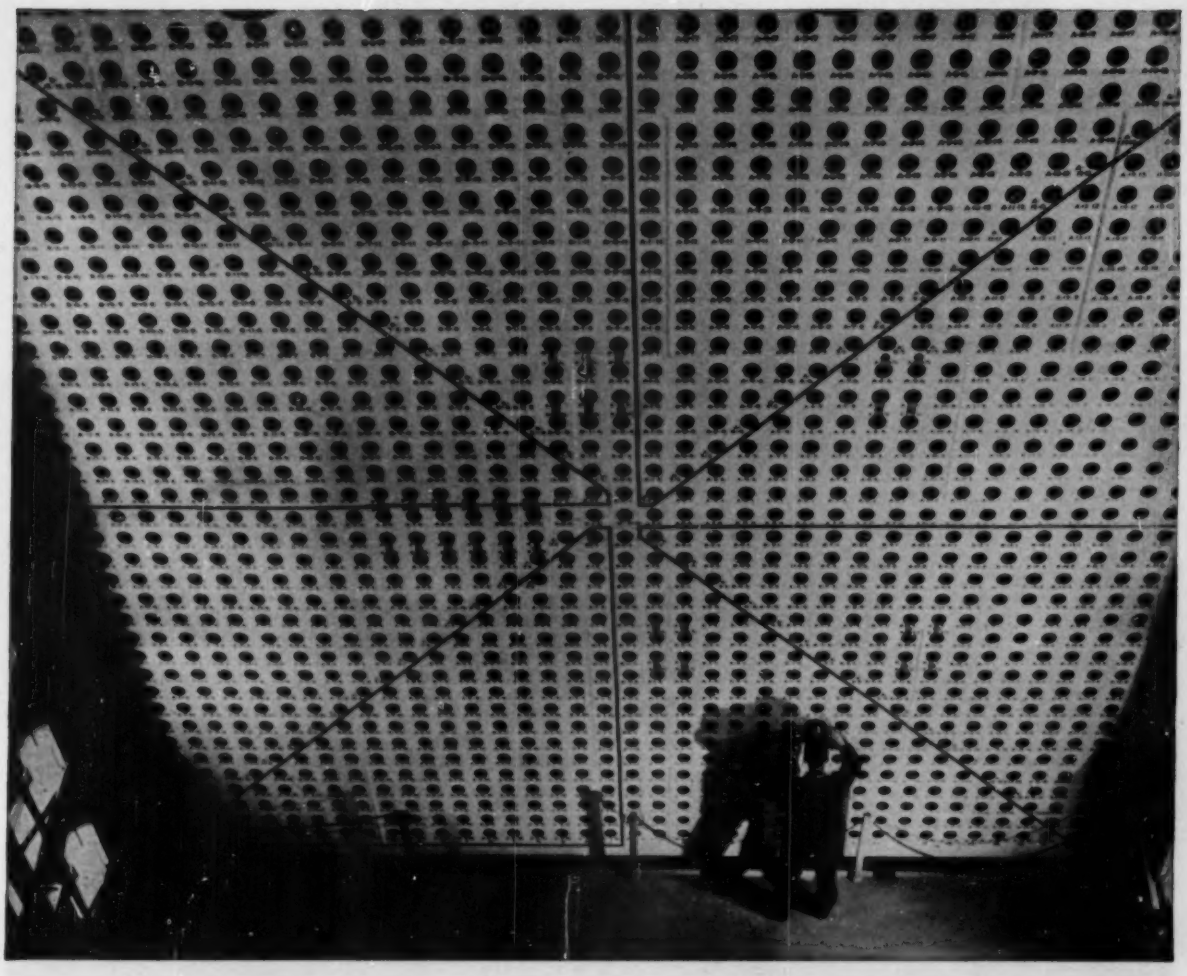
COMPLETE DATA and specifications are available—new 8-page Relay Guide.

THE HART MANUFACTURING COMPANY

118 Bartholomew Avenue, Hartford 1, Conn.

Phone JAckson 5-3491

Circle 368 on Page 19



PRECISE TUBING HELPS CONTROL ATOMIC REACTOR

In the intense heat and radioactivity of nuclear reactors, there are many uses for precise tubing, manufactured under rigid quality control.

This is one of the many important applications for BISHOP'S complete line of tubing up to 1 inch OD, in stainless, nickel, super and exotic alloys—and glass-to-metal sealing alloys, clad metals and composite wires.

BISHOP also produces a vast line of platinum products and chemicals.

And BISHOP is unique because of its ability to *work these metals to such small, precise forms.*

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Tubular Products Division **J. BISHOP & CO.** *platinum works* MALVERN, PENNSYLVANIA

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Tomorrow's tubing technology—today



Superior (SAE) hydraulic quality tubing—strength plus formability for safer systems

There are many reasons why Superior (SAE) hydraulic quality tubing is specified for application in hydraulic systems operating under pressures up to 3000 psi. It has an ultimate tensile strength of 60,000 psi max., a yield strength of 25/45,000 psi, and an elongation of 35/45% in 2 in. It has a recommended maximum working pressure range of 530 to 11,750 psi, depending on OD and wall thickness. Every length is hydrostatically tested under maximum working pressure. It is made of non-aging steel, maximum carbon content 0.12%. It is specially coated with a waxlike rust preventive.

Superior (SAE) hydraulic quality tubing has other important advantages too. It can be easily bent into angle turns or sweep bends—pipe fittings, which are subject to leakage, are eliminated. It does not require threading, which removes metal and weakens the wall. It absorbs vibration by reducing the number of fittings needed and by providing the required strength with minimum wall thickness. It has a bright, smooth, scalefree interior to minimize turbulence and pressure drop.

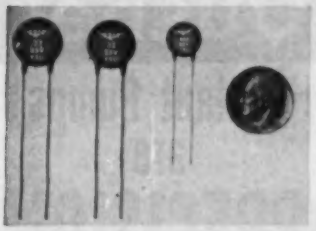
No matter what your small-diameter tubing requirements are, we can satisfy them. In addition to (SAE) hydraulic quality tubing, we offer more than 120 analyses in quantities from 50 to 1,000,000 ft. Sizes range from .010 in. to ⅝ in. OD. Bulletin 39 gives complete details about Superior (SAE) hydraulic quality tubing—write for a copy today. Superior Tube Company, 2010 Germantown Ave., Norristown, Pa.

Superior Tube ST

The big name in small tubing

NORRISTOWN, PA.

West Coast: Pacific Tube Company, Los Angeles, California



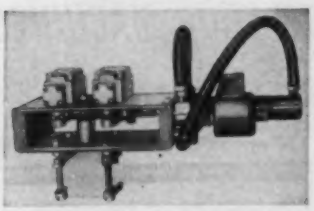
lead spacing is 0.375 in. for both units. Thickness of the 0.1 mfd is 0.156 in. and 0.200 for the 0.2-mfd unit. **Erie Resistor Corp.**, 644 W. 12th St., Erie, Pa.

Circle 682 on Page 19

Remote-Control Operator

for use with all makes of quarter-turn ball valves

Remote-control operators are ruggedly constructed and are mounted on valves with universal hangers. Neither the operator nor its accessories are attached to the piping. Design eliminates side-play action and valve stem strain. In addition to providing positive, remote control of standard quarter-turn ball valves, operators are used to operate specially designed and modified quarter-turn valves used in ground-support cryogenic service of missile and space programs. Operators are available with various combinations of controlling solenoids, limit switches, and valve positioners. Stock sizes range from ¼ to 3 in. for screwed-end valves and from



½ to 4 in. for flanged-end units. **Ju-No Supply Corp.**, P. O. Box 1116, Clearwater, Fla.

Circle 683 on Page 19

DC Torque Motors

have peak torques from 20 to 350 oz-in.

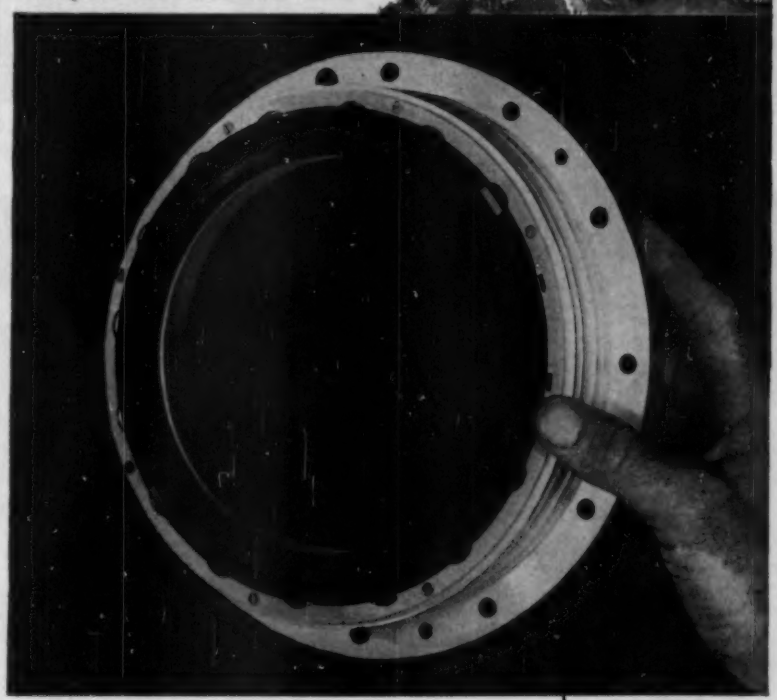
Direct-drive dc torque motors are available for applications requiring a high order of angular resolution

Now...Borg-Warner Mechanical Seals for Airborne Applications



Developed especially to meet the reliability requirements of airborne components, this new Borg-Warner Mechanical Seal combines compact size with lightweight metallurgy. Entirely new—yet this same basic design has been proved in almost every type of industrial and military shaft sealing job.

Borg-Warner Mechanical Seals are used daily under high pressures, for high or ultra-low temperatures, to seal toxic, corrosive and volatile liquids, and even for radioactive fluids. ***Whatever your needs for sealing a rotating shaft, specify Borg-Warner Mechanical Seals!***



Typical operating conditions—rocket engine fuel pump at 7450 rpm and 250°F.

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Mechanical Seals

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SEE OUR FILE IN SWEETS DESIGN CATALOG—SECTION 8e

Circle 371 on Page 19

LOOK

AT WHAT YOU CAN DO WITH MODERN TORQ SPEED DETECTORS

JET ENGINES



In event of overspeed, automatically actuate the control circuit. Torq speed switches for aircraft are temperature compensated, inherently balanced and produced to required military specifications.

SAW MILLS



Automatically withdraw cutting blade due to overload for any reason.

MACHINE TOOLS



Automatically brake and shift transmission at proper pre-determined speeds selected by push button.

METER SCALES



Automatically switch scale ranges where rotary speed is a function of the measurement.

ELEVATORS



Cut in braking circuit if unit overspeeds, or falls below operating speed due to overload.

GAS ENGINE GENERATOR SETS



Automatically switch from cranking cycle and protect against overspeed.

DIESEL ENGINES



Switch out cranking motors, engage and disengage cooling circuit, supply varying fuel requirement, signal full speed.

TRUCK REFRIGERATORS



Maintain proper alternator output at all truck speeds by automatic shifting of alternator transmission at pre-determined truck engine r.p.m.

Torq speed detectors are small, snap-acting, rotary centrifugal switches for actuating one or many circuits at one or more pre-determined speeds from 0 to 15,000 r.p.m. — they operate on speed only, independently of all other conditions — can provide up to 3 million cycles of uniform operation at tolerances to ¼ of 1% — are designed on a patented "friction-free" principle — and are available in a wide range of sizes, models and operating characteristics to meet practically any application.



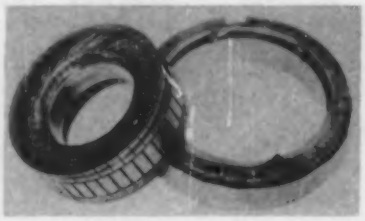
Patents and Patents Pending

Write or phone for additional data.

TORQ ENGINEERED PRODUCTS, INC.

26 WEST MONROE STREET • BEDFORD, OHIO, U.S.A.
Phone: BEdford 7-4100

Circle 372 on Page 19



and/or response at the load. Standard models have peak torques of 20 to 350 oz-in. Model DCTM 29-2 has peak torque of 60 oz-in. with input power of 32 w. Frameless unit is approximately 2.8 in. diam, 1 in. wide, and weighs 14 oz. **Giannini Controls Corp.**, 1600 S. Mountain Ave., Duarte, Calif.

Circle 684 on Page 19

Expansion Joints

have one-piece construction

Rubber expansion joints are abrasion-resistant rubber, compounded for maximum flexibility and nonset characteristics. Joints are reinforced with heavy-weight duck and are coated on the outside with neoprene. They are also available with an internal neoprene lining or with neoprene throughout. Rubber flanges are an integral part of the body, providing easy installation and assuring a tight seal without gaskets. Standard spool-type joints are available for pipe sizes from 2 to 72 in. Vacuum-type joints are



designed for 30 in. of mercury and pressure-type joints for 0 to 150 psi, depending on size. **Dept. MD-1, Crane Packing Co.**, 6400 W. Oakton St., Morton Grove, Ill.

Circle 685 on Page 19

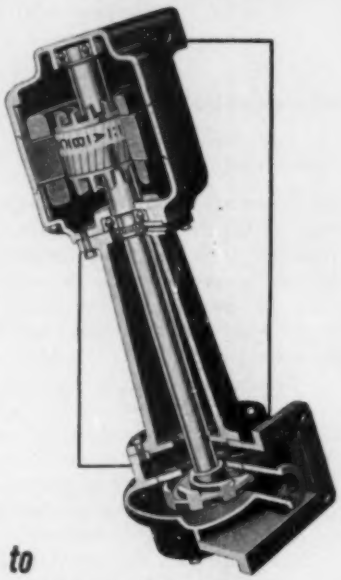
Laminated Plastic

has high flexural strength

Type 11601 Textolite general-purpose punching grade of laminated

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Coolant Pumps are PRECISION BUILT



to

- **LAST LONGER**
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ON YOUR MACHINES

You get better performance from your GUSHER Coolant Pumps because they are precision built. The one piece shaft in GUSHER Pumps is electronically balanced to cut vibration to a minimum. Ball bearings are pre-lubricated, no seal or packing needed. Write for catalog.

THE **Ruthman** MACHINERY CO.

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• CIRCULATORS • AGITATORS
• MOLTEN METAL PUMPS

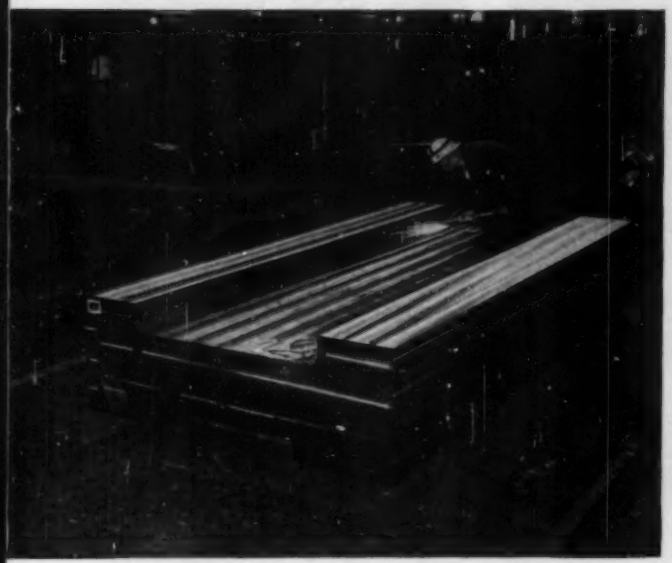
1811 Reading Road • Cincinnati 2, Ohio

Circle 373 on Page 19

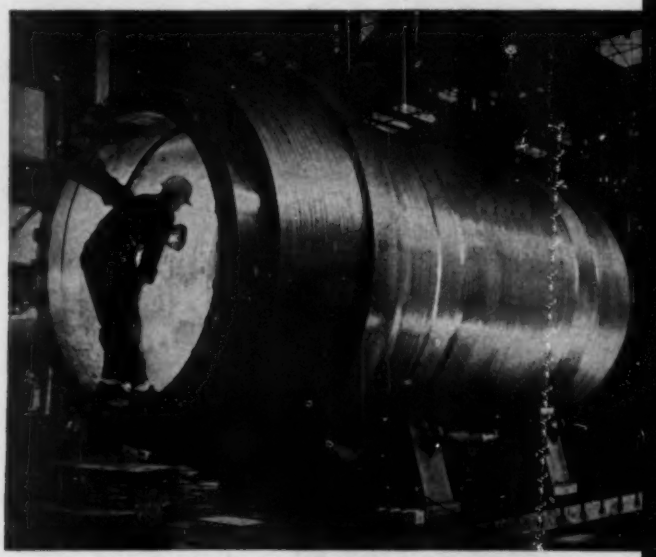
You name it...we'll forge it!

RIGHT ON THE NOSE. Bethlehem meets your specifications exactly on all types of press, drop, and hammer forgings.

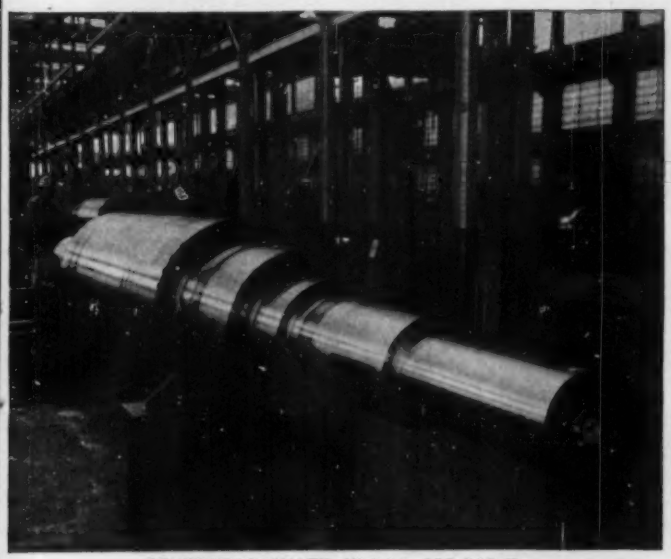
for Strength
... Economy
... Versatility



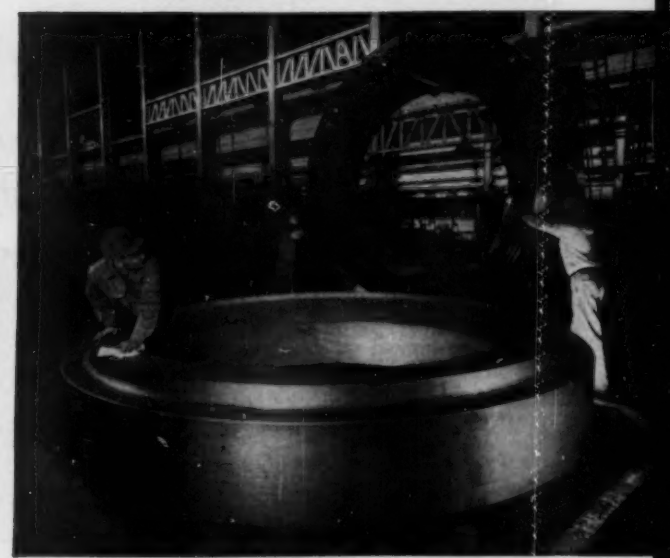
RAM ADAPTER. This forging weighs 58,780 lb, and measures 140 in. x 73 in. x 25 in.



STEEL CYLINDER for use in 7,500-ton plate stretcher. This forging weighs 171,240 lb, and it's 17 ft, 3 in. long.



GENERATOR SHAFT. Weight, 198,240 lb. As you can tell from these photos, Bethlehem is well-equipped for machining.



REACTOR VESSEL CLOSURE. The OD of this 50,660-lb forging measures 12 ft.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA. *Export Sales:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

Circle 374 on Page 19



Just Published! *comprehensive book to help you in the selection of gears*

Farrel's new "Gear Manual" is ready for distribution now. Here are 68 pages of practical, authoritative information that you will find helpful when selecting gears.

Sections devoted to gear selection include: nomenclature, formulas for determining dimensions, procedure for calculating horsepower ratings and sample calculations. Gears for special use, such as in rolling mills and kilns and for pump rotors, are covered. Also discussed: lubrication, gear-tooth wear and failure and use of the gear-tooth comparator.

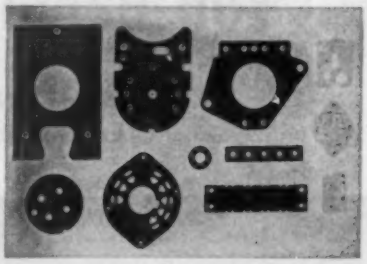
The manual is informative yet easy to use. Where possible, formulas have been simplified to reduce the calculations required.

Write for a copy today on your company letterhead.



FB-1227

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P.O. Box 2071, Buffalo 5, N. Y.
Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N. Y.
Sales Offices: Ansonia, Buffalo, Akron, Chicago, Minneapolis, Denver, Los Angeles, San Francisco, Seattle, Salt Lake City, Tulsa, Houston, Atlanta
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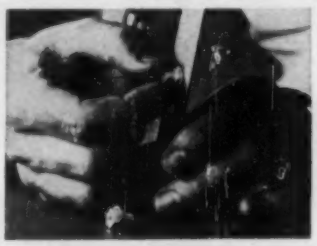
plastic is a warm-punch type of phenolic - paper composition. It meets NEMA specifications for both X and P grade materials. Grade has excellent flexural strength, dimensional stability, and uniformity. It is available in natural, black, and chocolate in thicknesses from 0.020 to 0.150 in. Standard sheet sizes are 36 x 72, 36 x 48, and 36 x 36 in. **Laminated Products Dept., General Electric Co.,** Coshocton, Ohio.

Circle 686 on Page 19

Feed-Through Capacitors

have ratings from 4.7 to 1.0 mf

Solid-tantalum, hermetically sealed feed-through capacitors are available for chassis-wall mounting. Capacitors carry low-voltage, dc circuit leads through sheet-metal portions of electronic chassis to bypass radio-frequency noise. Capacitors have current ratings from 1.0 amp at 25



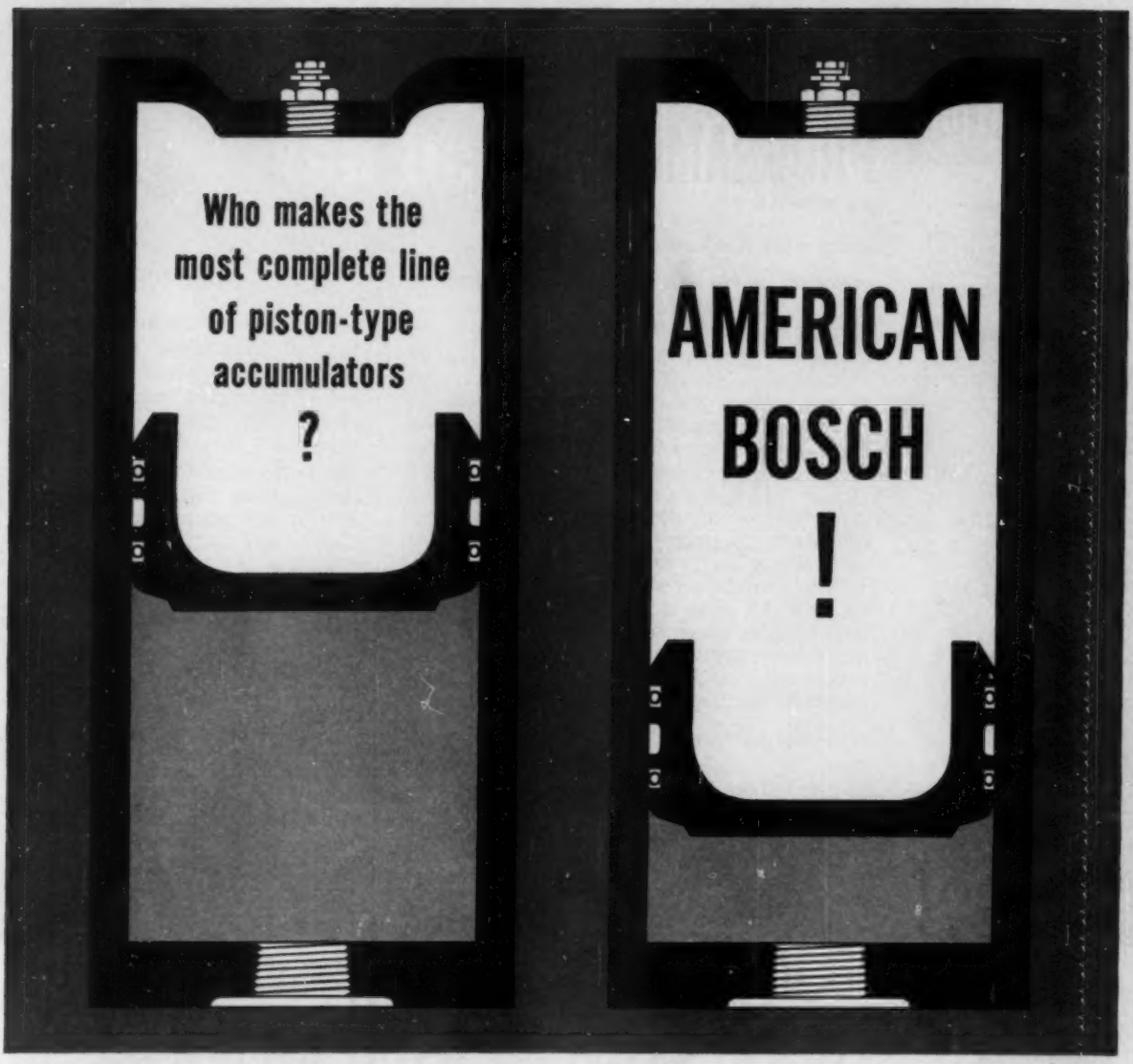
C to 0.4 amp at 125 C, with working voltages at ambients above 85 C requiring 67 per cent linear derating to 125 C. **Rectifier-Capacitor Div., Fansteel Metallurgical Corp.,** North Chicago, Ill.

Circle 687 on Page 19

Precision Racks

of Type 416 stainless steel

Certified precision spur-gear racks are available in eight diametral-



Proved for performance and reliability, American Bosch piston-type accumulators provide a powerful work-force for hundreds of industrial, marine, and mobile applications. Sizes range from less than a quarter pint to twenty gallons. Models are available for a variety of pressures in both steel and aluminum—in many diameters, lengths, and capacities. Custom-made models built to specifications.

American Bosch accumulators are manufactured to meet the most rigid requirements. Various types conform to MIL-A-5498C, ASME, JIC and U. S. Coast Guard specifications. When you specify accumulators for hydraulic systems, call for American Bosch. Complete information is contained in a new folder AC 110-02-2 . . . write for a copy and the name of your nearest distributor today.

8540

MOVE AHEAD

AMERICAN BOSCH ARMA CORPORATION

Commercial Sales Division • Springfield 7, Massachusetts



ACCUMULATORS FOR INDUSTRIAL, MARINE, AND MOBILE APPLICATIONS

Circle 376 on Page 19

PRODUCT APPLICATION

HANSEN
SYNCHRON
TIMING MOTORS

CLOCK PROGRAMMING
systems

using reset clock movements
powered by Hansen SYNCHRON motors



MINNEAPOLIS-HONEYWELL REGULATOR COMPANY incorporates Hansen SYNCHRON Clock Movements in its Indicating Clocks and Master Control Systems — for installation in schools, public buildings, in industry, or wherever accurate time must be maintained. Single-dial Indicating Clocks are coordinated by Master Clock Programming, with automatic correction — to compensate for deviations caused by current fluctuations — available either on an hourly or 12-hour correction basis. Hourly correction resets the clock which may be from 55 seconds fast to 59 minutes slow depending on current fluctuations, at two minutes before the hour. The 12-hour correction occurs between 5:00 and 5:30 o'clock, automatically resetting clocks up to 12 hours slow.

HANSEN SYNCHRON CLOCK MOVEMENTS were chosen by Minneapolis-Honeywell because of satisfactory power and dependability experienced by a previous supplier to the firm. Hansen SYNCHRON motors are connected to reset movements through a gear, clutch and cam arrangement. The clock systems operate with 60-cycle and 24-volt motors, on 115-volt current — generally most readily available on typical installations.

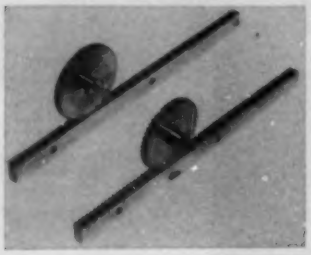
SEND TODAY for informative folder containing specifications and technical data on all Hansen SYNCHRON motors and clock movements.



HANSEN MANUFACTURING COMPANY, INC.
PRINCETON, INDIANA

HANSEN REPRESENTATIVES:
THE FROMM COMPANY
5150 W. Madison, Chicago, Illinois
H. C. JOHNSON AGENCIES, INC.
Rochester, N. Y. — Buffalo, N. Y. — Syracuse, N. Y.
Binghamton, N. Y. — Schenectady, N. Y.
ELECTRIC MOTOR ENGINEERING, INC.
Los Angeles, Calif. — (OLive 1-3220)
Oakland, California
WINSLOW ELECTRIC CO.
New York, N.Y. — Essex, Conn. (SOuth 7-8229)
Philadelphia, Penn. Cleveland, Ohio

Sweet's Product Design File



pitch sizes from 24 to 96. Manufactured from Type 416 stainless steel, racks are furnished in standard 11-in. lengths, precision ground on all sides, and are available in Precision 1, 2, and 3 classifications. With ends ground to ½ linear pitch, racks can be butted where greater lengths are required. **PIC Design Corp.**, 477 Atlantic Ave., East Rockaway, L. I., N. Y.

Circle 688 on Page 19

Long-Stroke Diaphragms

have low permeability characteristics

Long-stroke, elastomer diaphragms are friction-free, rolling-type units which provide an effective pressure area which remains constant throughout its stroke. Diaphragms are virtually leakproof, have low permeability characteristics, and can be used with an almost infinite range of fluids and gases. Low-pressure diaphragms (without



fabric), and high-pressure units (with fabric) are offered. **Diaphragm Industries Inc.**, 102 Rantoul St. Beverly, Mass.

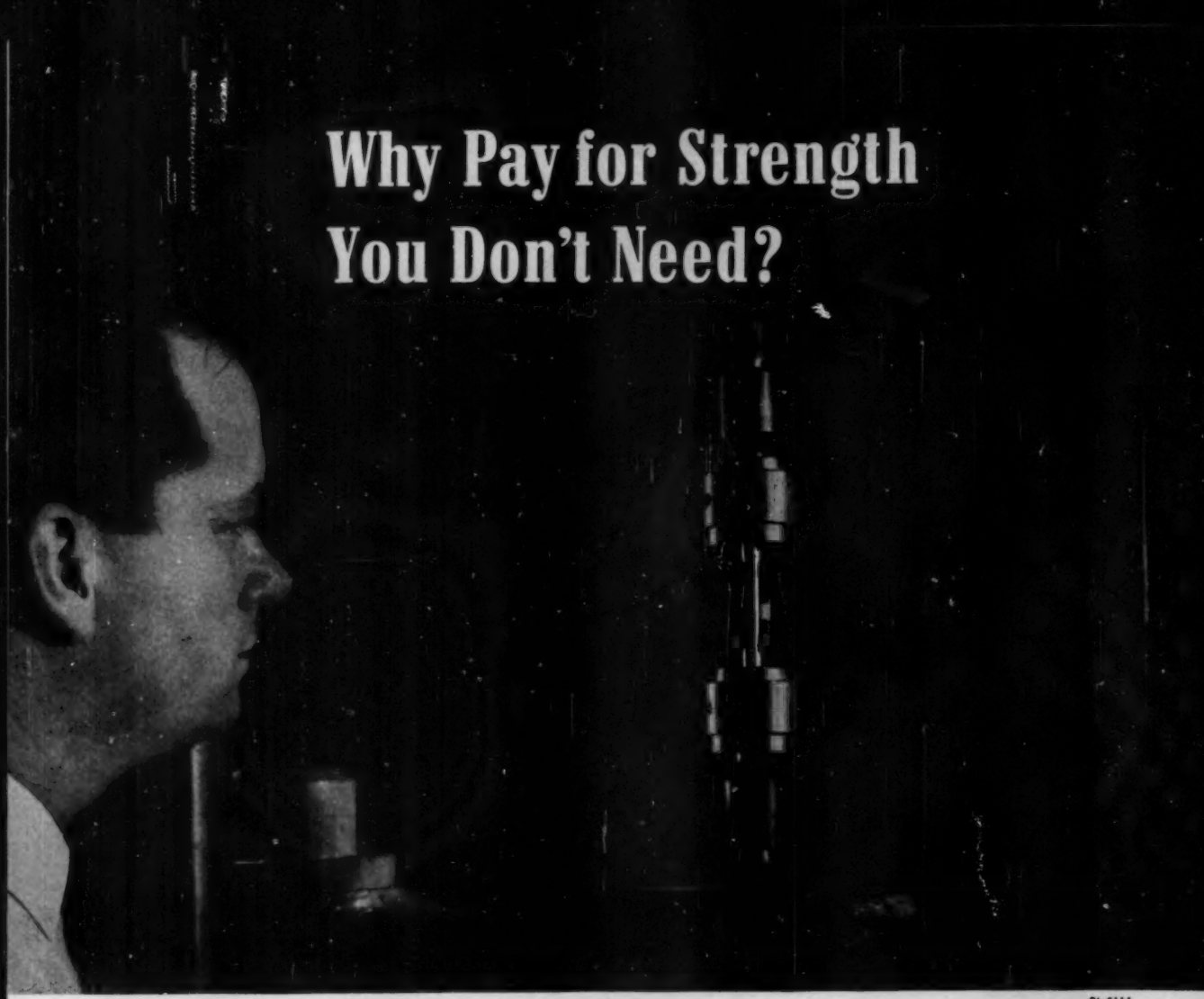
Circle 689 on Page 19

Heat-Dissipator, Retainer

for application with TO-18 transistors

Designed for application with TO-18 package, and designated TXBP-018-028, new dissipator is beryllium copper with spring-finger construction.

Circle 377 on Page 19



BL-6114

Cut Costs with STRAIN-TEMPERED®

Industry's widest range of high strength bars

Why do you settle for a "packaged" high strength bar? You may be paying for strength you don't need. Or for unnecessary machinability. Or for some other characteristic you don't really require.

There are so many combinations of properties available in the extensive Bliss & Laughlin Strain-Tempered line of high strength cold finished steel bars, you need pay only for the properties demanded for your field service and machining. No other line provides the variation of analyses, strengths and machinability—in carbon and alloy, non-leaded and leaded. Tensile strengths range from 125,000 to 200,000 psi, yield strengths from 100,000 to 165,000 psi. Over 30 years of Bliss & Laughlin pioneering experience with high strength steels assures dependable quality and delivery. Don't settle for less!

Write for a new 20-page booklet which discusses the unique combination of properties and points out the money-saving advantages of Strain-Tempered high strength steels. You will value it!

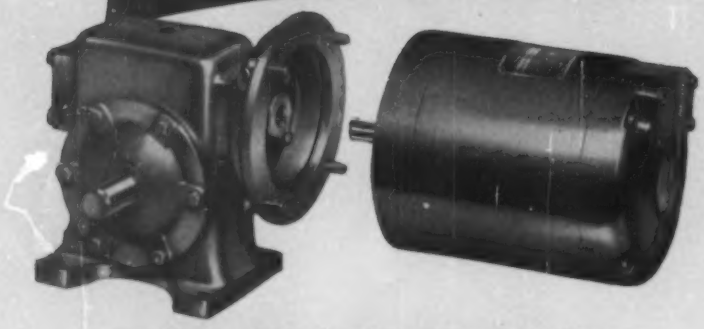
Leading Independent Producer of Cold Finished Steel Bars

BLISS & LAUGHLIN

GENERAL OFFICES: Harvey, Illinois MILLS: Harvey, Ill., Detroit, Cleveland, Buffalo, Mansfield, Mass., Los Angeles, Seattle

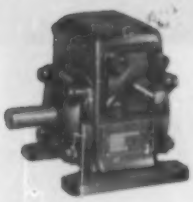
Circle 378 on Page 19

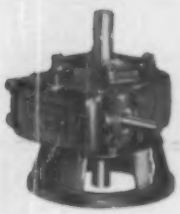
Precision Engineered-
Performance Tested



PERFECTION
Worm Gear
SPEED REDUCERS







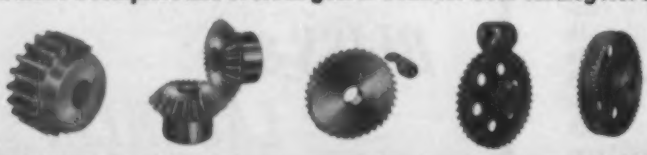
One of our major capabilities is to design, develop and produce speed reducers that will insure maximum performance and economy in your operation. Our experience in the special problems and objectives of power transmission is broad and deep. The men at American Stock Gear having this important capability, use the most advanced analytical engineering facilities to design speed reducers to meet tomorrows needs.

Whatever size or style reducer you need, you'll find the right combination in the complete Perfection line — a line that is precision engineered and performance tested in thousands of different applications.

If you have a reducer problem that you feel is "different", our engineers are ready to advise, design and produce speed reducers to your particular requirements. In the meantime, write for your copy of our Reducer catalog containing illustrations, charts and tables to help you on your next application.

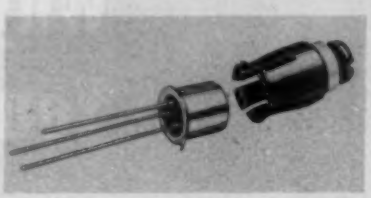


We make a complete line of stock gears. Send for Gear catalog No. 360.



AMERICAN STOCK GEAR DIVISION
PERFECTION GEAR COMPANY, HARVEY, ILLINOIS

Circle 379 on Page 19



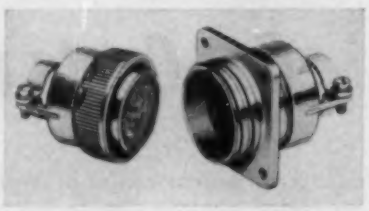
It accommodates case diameter variations from 0.175 to 0.190 in. Use of the retainer unit provides maximum thermal contact with transistor case, resulting in efficient transfer of heat from transistor case to the dissipator and heat sink. Methods for mounting are simple and suitable for printed-circuit boards, chassis, and heat sinks. Retainer is available in Insulube or black cadmium finish. **IERC Div., International Electronic Research Corp.**, 135 W. Magnolia Blvd., Burbank, Calif.

Circle 690 on Page 19

Miniature Plug

exceeds all requirements of MIL-C-25955

KM Mark 2 miniature plug features crimp, snap-in contacts. It offers through-grommet insertion, extraction of contacts for wiring and maintenance simplicity, and exceeds requirements of MIL-C-25955. Unit mates with KO and KM plugs pres-



ently in use. **Cannon Electric Co.**, 3208 Humboldt St., Los Angeles 31, Calif.

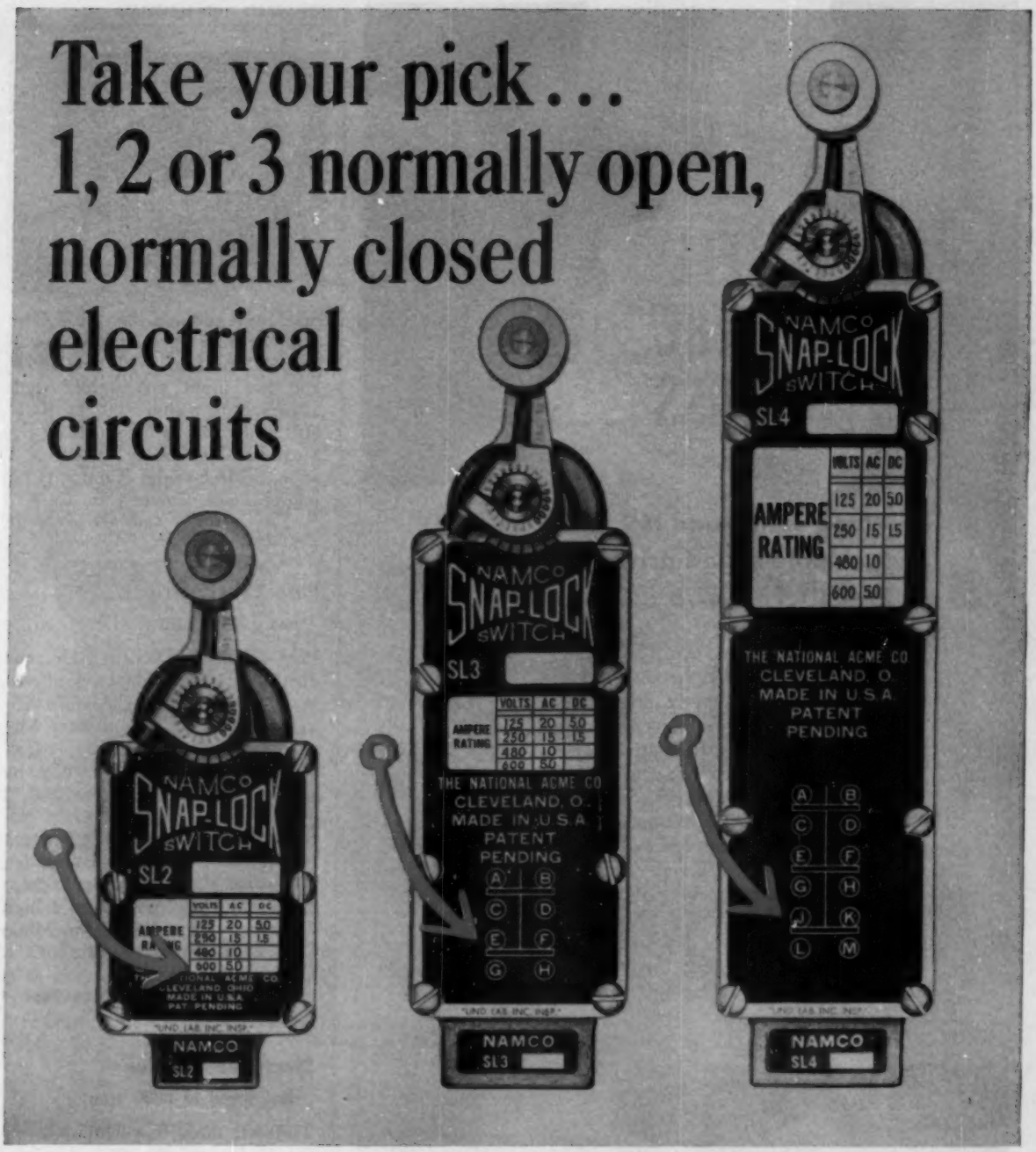
Circle 691 on Page 19

Rotary Seal

operates in temperatures from −300 to +165 F

Hermetically sealed rotary unit seals with a precision cone-shaped bellows in a divided shaft driven through an eccentric. Unit functions completely immersed in liquid nitrogen, coupled and sealed with a precision potentiometer. Seal is en-

Take your pick... 1, 2 or 3 normally open, normally closed electrical circuits



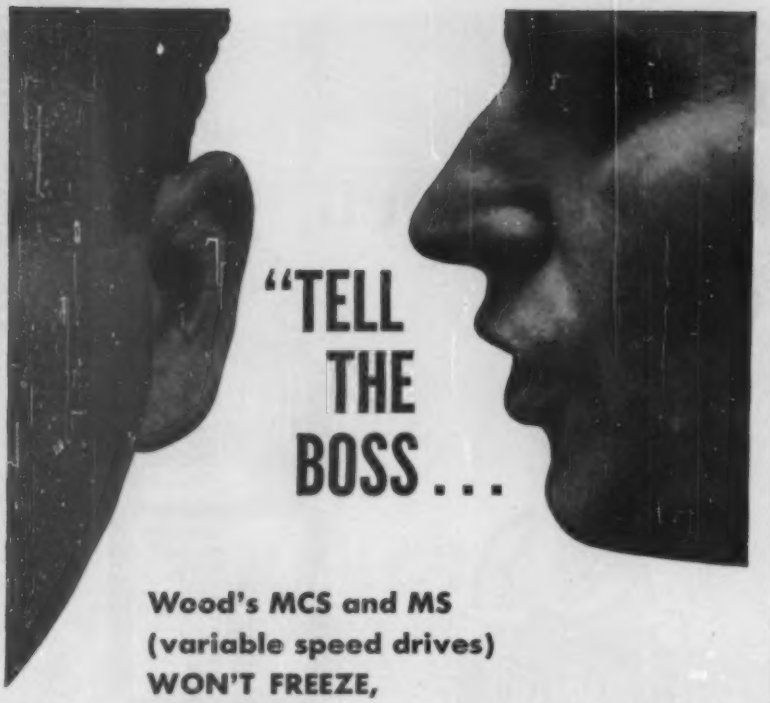
What does your limit switching application call for . . . one, two or three normally open, normally closed electrical circuits? Whatever it is, one of these National Acme SL "Machine Life" Limit Switches . . . the SL2, the SL3 or the SL4 . . . will meet your precise requirement. And, every SL offers . . . a variety of cam arrangements for extreme operating flexibility . . . ample overtravel (67°) and by-pass (90°) . . . light operating pressure (10½ lbs. at 1½" radius). Also available . . . the SLS 2, 3 or 4 featuring "hi-shock" sliding contacts; particularly suitable for drop forge, punch press and other heavy equipment application. Call, write or wire for complete information.

National Acme

THE NATIONAL ACME COMPANY
188 E. 131st STREET
CLEVELAND 8, OHIO

Sales Offices: Newark 2, N. J., Chicago 6, Ill., Detroit 27, Mich.

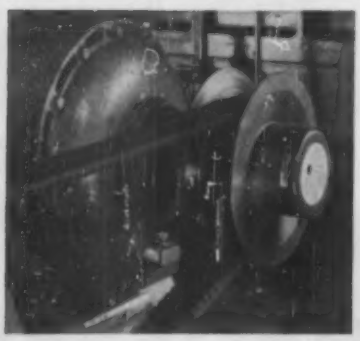
Circle 380 on Page 19



"TELL THE BOSS . . .

Wood's MCS and MS (variable speed drives) WON'T FREEZE, WON'T STICK"

And, remind him that Wood's MCS and MS motion control drives solve production and maintenance problems no other mechanical variable speed drives can handle. They won't freeze or stick because there are no keys to obstruct lubrication of bearing surfaces. Revolutionary resilient cam followers or pads, located outside the bearing surfaces, permit continuous rotational pumping action, assure even distribution of oil. And, you check lubrication only three or four times a year. Also, Wood's MCS drives hold constant driven speeds under varying torque loads.

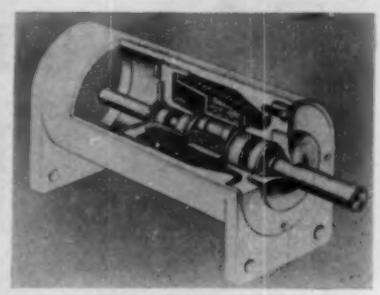


Wood's motion control, variable speed drives are available in capacities from fractional to 25 hp. If you and the boss want more information about these remarkable drives, write for BULLETIN 25103.

Woods

T. B. WOOD'S SONS COMPANY · CHAMBERSBURG, PENNSYLVANIA

MCS/2361 ATLANTA · CAMBRIDGE · CHICAGO · CLEVELAND · DALLAS



cased in a stainless-steel shell 1 in. diam by 1.25 in. long, operates in temperatures from −300 to +165 F, and has input and output shaft alignment to within 0.002 in. Backlash at 1 oz-in. is 6 seconds of arc. Maximum breakaway torque is 1 oz-in. **Mechtronics Corp.**, 11431 Joanne Place, Culver City, Calif.

Circle 692 on Page 19

Pure Cobalt Strip

has good ductility

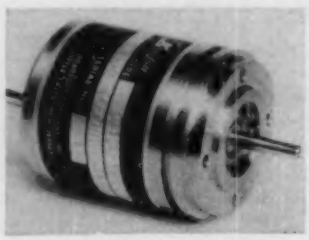
Pure cobalt coiled strip with good ductility and workability is offered in thicknesses from 0.005 to 0.025-in. and widths of ¼ to 6-in. Mechanical properties of the cobalt strip can be adjusted readily by proper heat treatment. Material is available for applications where corrosion resistance and high strength at high temperatures are essential. It also has excellent magnetic properties which are retained to a high Curie point. **Sherritt Gordon Mines Ltd.**, 25 King St. W., Toronto 1, Ontario, Canada.

Circle 693 on Page 19

Synchronous Motor

has speed of 8000 rpm

T170-001 Size 15 synchronous motor is for use in ground-support equipment, timing devices, recorders, and wherever constant speed is required despite load or line voltage variations. Motor is a six-pole,



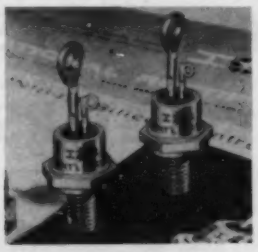
115-v, 400-cycle unit having a synchronous speed of 8000 rpm. Four variations can also be supplied. Unit weighs 7.5 oz. **Kearfott Div., General Precision Inc., 1150 McBride Ave., Little Falls, N. J.**

Circle 694 on Page 19

Silicon-Controlled Rectifiers

in 10 and 16-amp units have fast switching speeds

Two series of silicon-controlled rectifiers, including JEDEC types, have microsec switching speeds and a firing current of 5 ma at 100 C. JEDEC types 2N1842 through 2N1849, rated at 10 amp over a PRV range of 25 to 400 v, operate over a temperature range of −40 to +100 C. Second series, rated at



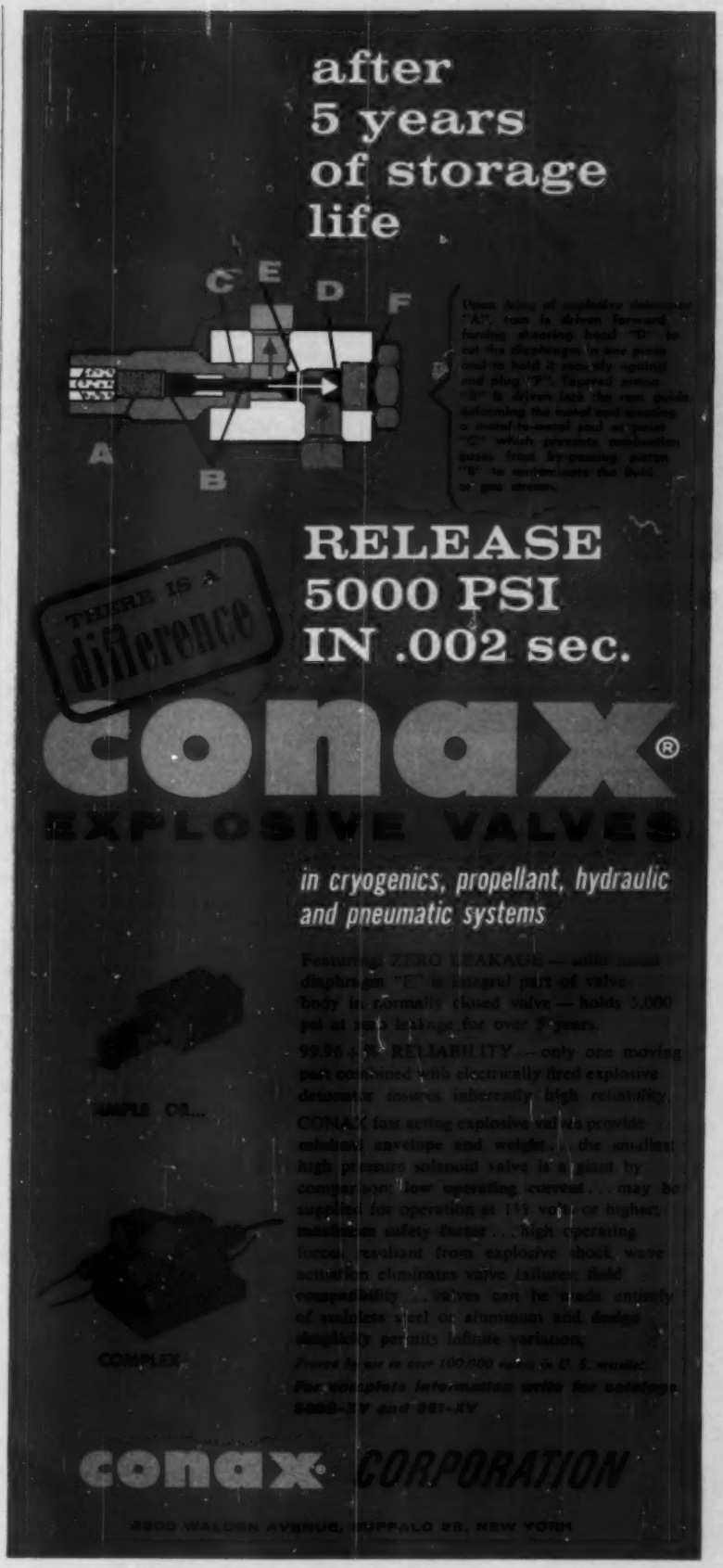
16 amp over a PRV range of 25 to 400 v, is designated with type numbers 16RC2 through 16RC40. They are electrically, but not mechanically, equivalent to JEDEC types 2N681 through 2N688, and operate over a temperature range of −65 to +125 C. Both series withstand a peak one-cycle surge current of up to 150 amp. **International Rectifier Corp., 233 Kansas St., El Segundo, Calif.**

Circle 695 on Page 19

Motor-Driven Pump

furnishes flows from 1.5 to 2.5 gpm at 225 psi

Model RG 17400 pump for cooling systems on electronic and other precision equipment is an electric motor-driven, spur-gear unit design for operation in dielectric coolant fluids. Motor is a submerged type designed to reduce weight and size in self-contained pump-motor assemblies. Integral relief valve furnishes flows from 1.5 to 2.5 gpm at pressures to 225 psi. Unit operates with 115/200-v, 400-cps ac power. Spur-gear



Circle 382 on Page 19



pumping element has a displacement of 0.0385 cu in. per revolution and operates at a speed of 11,000 rpm. Lear-Romec Div., Lear Inc., 241 S. Abbe Rd., Elyria, Ohio.

Circle 696 on Page 19

Adhesive Film

gives bonds to 1500 psi

Pre/Set adhesive film assures excellent bonds with application of heat and moderate pressure. Bonds are obtained at a temperature range of 150-250 F for 3-5 sec with standard squeeze-roll pressures. Subsequent cold-squeezing or pressing is desirable, but not essential. Where maximum bonds are required, a cycle of 300-400 F for 5-10 sec and 5 psi and higher should be used. Bonds give tensile shears of 1000-1500 psi immediately upon stabilizing at room temperature. Bonds resist shock, moisture, water, solvent vapors, moderate oil, and solvent exposure. Material has high affinity for a variety of surfaces, especially those usually difficult to bond. Girder Process Inc., 102 PT Hobart St., Hackensack, N. J.

Circle 697 on Page 19

Manual Starter

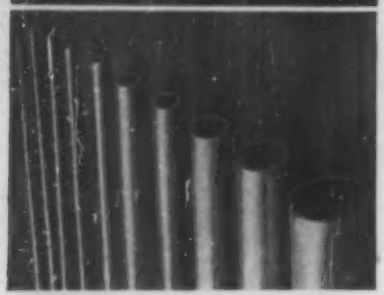
for two-speed, fractional-horsepower motors

Requirement of accurate overload protection for both speeds on single-



quick source for fine Seamless Tubing in

NICKEL ALLOYS



NICKEL

"A" nickel, 220, etc. Excellent cathode emission, high strength and rigidity at elevated temperatures for electronic and instrument applications.

MONEL

The all-purpose nickel alloy—non-corrosive, non-contaminating—in chemical processing, food, petroleum, marine, rocket motor applications.

INCONEL

Resistance to corrosives particularly recommends it for food, dairy and pharmaceutical applications; dental, surgical and industrial instruments; rocket and jet fuel lines, etc.

30 CUPRO-NICKEL

Copper-based alloy widely used for fine wire connectors, prongs and electrical contact tips, electrical and medical instruments.

Sizes: from .005" O.D. to .375" O.D.
Wall Thicknesses: from .035" to .0005".
Tolerances: to ±0.00005".
Delivery: Normally 3 weeks for tubing, 4 weeks for fabrications.
Fabricated Parts: a complete service specializing in burr-free, close-tolerance cutting, bending and flaring.

Write for information on tubing or tubular parts, made from these alloys, as well as many other alloys of aluminum, copper, steel, the precious metals, glass-sealing and refractory alloys.

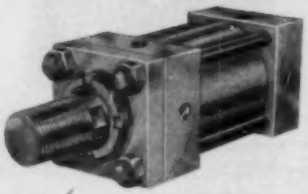
UF
UNIFORM TUBES, INC. COLLEGEVILLE 2, PA.
HUxley 9-7276 TWX-CGVL 1044

Circle 383 on Page 19

A-O-K



AIR and HYDRAULIC CYLINDERS and BOOSTERS



A O K Speed
A O K Performance
A O K All Sizes
A O K All Styles
A O K All Pressures (Standard up to 3000 psi.)
A O K Prompt Delivery
A O K Engineering Service

Find us fast in the 'Yellow Pages'

Call or Write

A-5328A

The G-P Manufacturing Corp.
A BASSETT COMPANY
ESTABLISHED 1916
30201 Aurora Road • Cleveland 39, Ohio

Circle 384 on Page 19

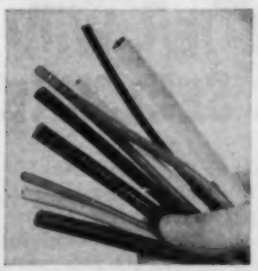
phase, two-speed motors is met by new ac, two-speed, fractional-horsepower manual starter. Small, 4-in. square, two-speed switch features a single, rotating operating knob with a clearly marked "High-Off-Low" legend for speed selection and "Reset" after overload. Four types of mounting availeble are NEMA 1 surface, flush panel, machine cavity, and plaster-cover mounting in a standard 4-in. square box. It is available with or without pilot lights. **Cutler-Hammer**, 315 N. 12th St., Milwaukee 1, Wis.

Circle 698 on Page 19

Acrylic Sleeving

retains good flexibility on heat aging

Hygrade AC-761 acrylic coated glass-fiber sleeving retains good flexibility on heat aging at rated temperature, and has indefinite shelf flexibility. It is compatible



with acrylic, epoxy, polyester, phenolic, and Formvar, and is noncorrosive to conductor wire. Sleeving has good electrical characteristics and exhibits excellent oil and cut-through resistance. **L. Frank Markel & Sons**, Norristown, Pa.

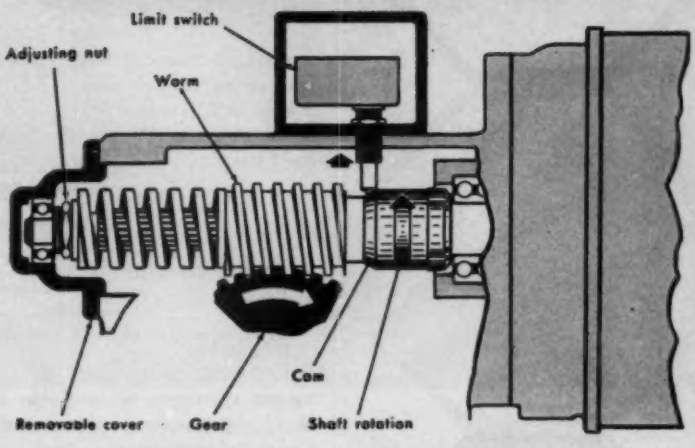
Circle 699 on Page 19

Impulse Counter

has miniaturized dial

Atcotrol 310-B automatic reset impulse counter utilizes new impulse motor; unit requires a pulse of only 50 millisec. Miniaturized dial-type counter has standard ranges of 1 to 40, 2 to 120, 4 to 240, 5 to 480, and 10 to 960, and counts at 500 counts per minute. Counter incorporates a 14-point terminal block for external wiring of all connections, plug-on internal wiring, choice of four panel mountings, and quick-

NOW POSITIVE PROTECTION for MOTORS and MACHINERY



As long as applied torque is within pre-determined limit, spring bears against end of worm and holds it centered on gear. Excessive torque causes worm to move axially along splined motor shaft, compressing spring and bringing cam surface in contact with limit switch which cuts power, stopping motor.

...JANETTE Adjustable Torque Overload Cutout

Here's *dependable* protection for drive units, driven mechanisms, personnel, and work in progress . . . and a sure-fire way to reduce down-time.

Janette Adjustable Torque Overload Cutout is far more sensitive than conventional shear pins, or friction clutches and similar devices. Its sliding worm on a splined shaft (described above) assures shutdown of the driving motor within closely controlled torque overload limits. Unit is easily reset when cause of overload is removed.

Color-coded, interchangeable springs permit selection of a wide range of torque limits. Each spring has a simple linear adjustment over its own range. Protect *your* equipment and avoid costly downtime the *positive* way . . . with Janette Adjustable Torque Overload Cutout. Write today for Bulletin 5-7.



SINCE 1910 **Janette** GEAR MOTORS MOTORS SPEED REDUCERS

Division of National Pneumatic Co., Inc., Boston 19, Mass.

Circle 385 on Page 19

WATERMAN

Series 190

FLOW REGULATORS

Constant Speed Operation

regardless of load!

At a cost comparable to an ordinary restrictor or needle valve, you can have pressure-compensated flow control in your hydraulic circuits.

Rated for pressures to 3000 p.s.i.

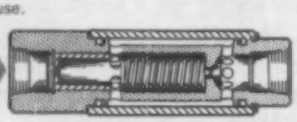
Wide range of sizes available—¼" to 1½" N.P.T.F. and ¼" to 1" S.A.E. tube.

Flows to 100 g.p.m. can be controlled.

Factory-calibrated and tested to ±10% tolerance. Closer tolerance available.

Require little more space than pipe or tube in which installed.

Trouble-free in operation—tens of thousands in use.



Unit senses pressure drop across precise orifice and reacts to control flow with desired limits.

Send today for new Catalog 1002.

NFPA

W-6108

WATERMAN

725 Custer Ave., Evanston, Ill.

Circle 386 on Page 19



disconnect terminal block. Standard load ratings are 10 amp at 115 v ac, 5 amp at 230 v ac, ¼ amp at 115 v ac. **Automatic Timing & Controls Inc.**, King of Prussia, Pa.

Circle 700 on Page 19

Torque Converter

for 3 to 7½-hp gasoline engines, some electric motors

Belt-driven, No. 500 automatic torque converter is available for 3 to 7½-hp gasoline engines and certain electric-motor applications. Unit provides load-free idling, smooth, 3:1 power-to-load ratio in "low" as engine is accelerated beyond 1650 rpm; automatic 1:1 power-to-load ratio in "high" as engine is accelerated beyond 2200-2600 rpm. Smooth, controlled tension between drive and driven pulley is available throughout entire operating range. Other features in-



clude efficient operation under adverse conditions of weather or terrain, quiet operation, and small, compact size. **Salsbury Corp.**, 1161 E. Florence Ave., Los Angeles 1, Calif.

Circle 701 on Page 19

Gang Switch Assemblies

in six basic types

Gang switch assemblies in a variety of mechanical and electrical locking



BETTER WITH A SEELSKREW*

SEELSKREWS*, SEELBOLTS* and SEELRIVITS* are high-pressure, self-sealing, vibration-resistant fasteners for critical military and industrial applications. They are dimensionally interchangeable with standard fasteners, and maintain tensile, torque and shear strength of standard non-sealing fasteners.

We also make:

HEXSEALS*

Modular external seals that fit onto switches, potentiometers, circuit breakers and lighted push buttons.

APM PRODUCTS MEET ALL APPLICABLE MIL SPECS.

Our list of modular seals is just too long for this ad. Let us send you our Catalog No. 359B.

*Trade Mark

Write or call: **MISS RIVA SOLINS**

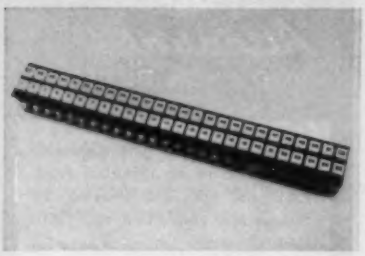
APM CORPORATION

41 Honeck Street, Englewood, N. J.

LOwell 9-5700

Circle 387 on Page 19

and interlocking matrices are now available. Six basic types are: Independent, momentary interlocking, independent locking and interlocking, locking and interlocking, locking and master release, and locking and interlocking with master release. Assemblies employ pushbutton switchlights mounted on either ¾ or 1-in. centers. Circuits are up to six pole, single throw or three pole, double throw, in combinations of normally open and normally closed contacts. Single and parallel lamp translucent pushbutton lenses snap in and key into place; they are manually removable for relamp-



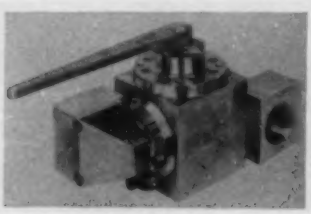
ing from front of panel. Lenses are available in 18 colors. **Pendar Inc.**, 14744 Arminto St., Van Nuys, Calif.

Circle 702 on Page 19

Shutoff Valve

delivers fluids under pressures to 6000 psig

No. 3-110325 high-pressure ball shutoff valve was specifically engineered as missile ground-support equipment for a propellant-loading and pressurization system handling nitrogen gas at temperatures from −65 to +160 F. Valve also handles UDMH and nitrogen tetroxide, and with minor modifications it is suitable for service with many cryogenic fluids, missile fuels, and oxidizers from −320 to +350 F. Line size is 1½ in. Valve body, trim, and internal parts are stainless steel; gaskets and seals are Kel-F or Teflon. Actuation can



IDEAL FOR AUTOMATED MACHINES



Maxitorq
ELECTRIC
CLUTCHES and BRAKES

Incorporating advanced design principles proved through years of service, the MAXITORQ Electric Clutch is well adapted to all types of machine drives. Simple in design . . . built to machine tool standards . . . requires no adjustments, can be used either as a clutch or brake. Disc separators not only separate discs, but also break up residual magnetism and result in extremely fast, positive action with no drag or heating in neutral. There are few moving parts. Electrical operating unit remains stationary — hence, no troublesome slip rings, brushes, or difficult wiring problems. Operation is on standard 100 V d.c. Other voltages on special order.

If you have a clutch or brake application where you are looking for NEW and IMPROVED performance, we invite you to bring the problem to us. Phone, wire, or write Dept. MD for Bulletin No. 90.

SPECIAL FEATURES

Engaged entirely by magnetic flux.

Operate either on-off or by varying voltage for torque control.

NO troublesome slip rings or brushes.

NO levers, cams, or other highly stressed mechanical parts.

Operation is not dependent upon rotation.

Finished complete, assembled, and ready to install on shaft.



THE CARLYLE JOHNSON MACHINE CO.
MANCHESTER, CONN.

ICJ61

Circle 388 on Page 19



Pressure: to 540 psi.

Ten orifice sizes: 1/64" through 1/4".

Wide voltage range: standard with 115V. AC.; also 12, 24, 208, 230, 460V. AC. 50/60 cycle.

Body: brass bar stock or 18-8 stainless steel. All moving parts, stainless. Seat disc, synthetic rubber. Sizes, 1/4" and 1/8" NPT. Both conduit and grommet types.

Underwriters' listed as a safety valve

Yes, "Master-mite" is the mighty mite of solenoid valves. Useable on a wide range of media including hydrogen, acetylene, etc. Works right in any position. Small, but with extra strength in the Marsh manner. Coils never overheat. Leak tight. Remarkably quiet.

Ask for special bulletin

MARSH INSTRUMENT COMPANY
Division of Colorado Oil & Gas Corporation
Dept. B Skokie, Ill. Marsh Instrument & Valve Co., (Canada) Ltd., 8407 103rd St., Edmonton, Alberta. Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas. Eastern Seaboard Warehouse: Marsh Instrument Company, 1209 Anderson Ave., Fort Lee, N. J.

MARSH

GAUGES • THERMOMETERS
VALVES

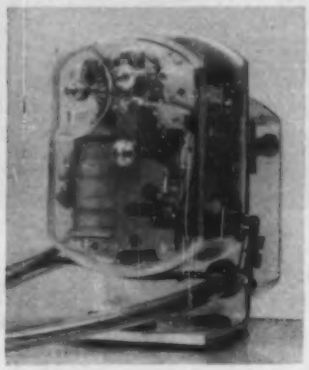
Circle 390 on Page 19

be manual, pneumatic, hydraulic, motor, or solenoid operated. Operating pressure is 6000 psig with 9000 psig proof pressure and 15,000 psig burst pressure. Operating torque is 10 lb-ft at 6000 psig. **Koehler Aircraft Products Co.**, 401 Leo St., Dayton 4, Ohio.

Circle 703 on Page 19

Sequence Timer

is battery-powered, accurate unit



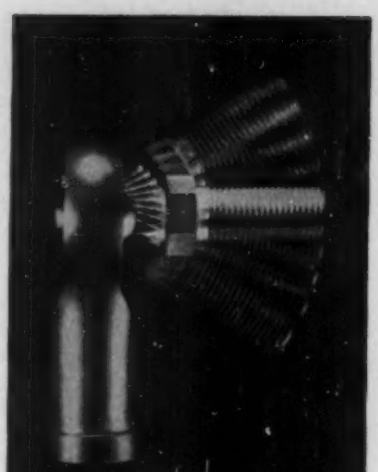
Compact chronometric timer provides switch closures and openings from once every 10 min to once every 12 hr. A small, 4.5-v, A-battery powers the timer for 8-12 months. Accuracy is ±10 sec per day over a temperature range of 30 to 140 F, unaffected by voltage fluctuation. The 15-jewel driving movement is temperature compensated and has shock-mounted pivot shaft. A single-pole, double-throw switch is actuated by a cam mounted on the output shaft. Cams are available with 1, 2, 3, 4, or 6 lobes, enabling the switch to be cycled as many times in a 1 or 12-hr period. Switch closure times are adjustable. **Geodyne Corp.**, 180 Bear Hill Rd., Waltham 54, Mass.

Circle 704 on Page 19

Component Clamps

for subminiature, T-3 envelopes

Series 7B Kool Klamps are furnished for subminiature T-3 envelopes in two types. Units are available with or without sockets for in-line and circular basing. Design is open finger-type sleeve to permit easy



WHAT MAKES
Alinabal
ROD ENDS BETTER?

One reason for the superior performance of Alinabal Rod Ends and Spherical Bearings is the precise control of the relationship of the spherical race to the ball.

Each Alinabal unit has a precision ground, through hardened steel race. Precise control of the race radius enhances low friction operation and prevents "end-loading" effects. This spherically ground race is manufactured for assembly around the ball, and is *not* a set of relatively soft, pressed inserts, nor is it a swaged housing. Moreover, loading slots are not used in the Alinabal construction method. Thus, the ball is positively and permanently retained under misaligning conditions.

Alinabal is the registered trade name for rod ends and spherical bearings manufactured under U.S. Patent 2,781,238.

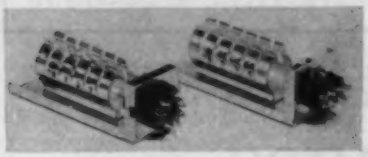
A complete line — standard male and female rod ends — stud type rod ends — standard spherical bearings and rod linkages — sizes range from 3/16" to 4" bore.

SEND FOR
COMPLETE CATALOG

split ballbearing

SBB DIVISION OF MPB
INCORPORATED
LEBANON, NEW HAMPSHIRE

Circle 391 on Page 19



top insertion and/or withdrawal. The open sleeve conforms to irregularities of the envelope to provide high contact and thermal conductivity. Material is beryllium copper No. 25 per QQ-C-533 in finishes of silver plate, Ebanol, cadmium, copper, gold, or plain. Lengths of the two types of clamps are 1¾ in. and 1 15/16 in. (with sockets), widths, 0.60-in. **Birtcher Corp./Industrial Div.**, 745 S. Monterey Pass Rd., Monterey Park, Calif.

Circle 705 on Page 19

Teflon-Slotted O-Rings

are suitable for use with nonflammable hydraulic fluids

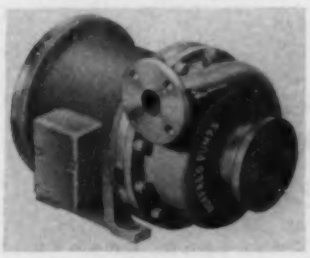
Style 9593 Teflon-slotted O-rings solve difficulties encountered with solid Teflon O-Rings. They fit standard AN grooves, improve automatic sealing action, are easy to install, provide low friction, and are suitable for use against nonflammable hydraulic fluids, solvents, acids, and other fluids. **Garlock Inc.**, Palmyra, N. Y.

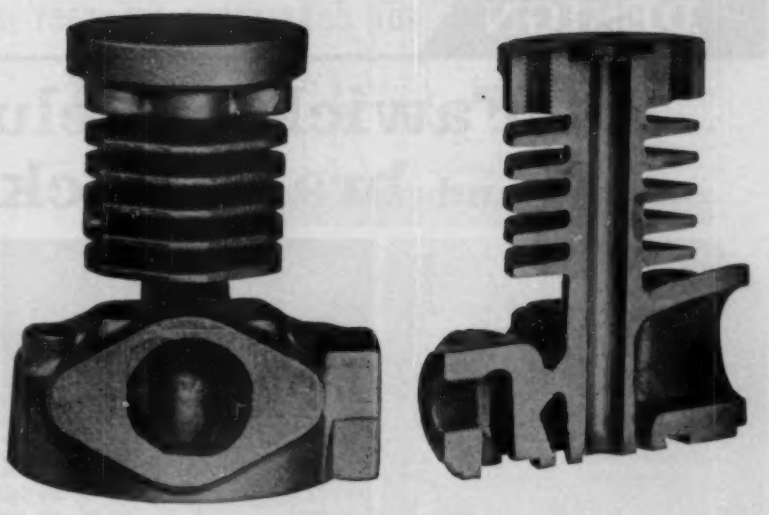
Circle 706 on Page 19

Centrifugal Pumps

are leakproof, single-suction units

New centrifugal pumps are totally enclosed, hermetically sealed units for use with toxic, inflammable, or highly volatile liquids. Design includes a long-life, self-adjusting bearing; mechanical seals and stuffing boxes are eliminated. The single-suction pumps have enclosed, hydraulically balanced impellers.





PRESSURE TIGHT

A CASE IN POINT—This 8 pound Meehanite Metal casting made for the Joy Manufacturing Co. by Hamilton Foundry is a fourth stage air compressor cylinder. Pressures build up to 6,000 p.s.i. and require a high strength, pressure tight and wear resisting casting. Alloyed Meehanite® oil quenched and tempered, raised Brinell hardness of the cylinder wall to 275-300, and increased tensile strength to 60,000 p.s.i. Meehanite was chosen for this casting because controlled structure and small uniform flake graphite produce pressure tight castings of uniform density and strength.

Meehanite is both an iron—and a controlled process. Through the Meehanite Process the microstructure and the quantity and form of graphite is consistently controlled. This means that a specific type of Meehanite can be selected to meet engineered casting requirements. Testing of every ladle of molten iron insures that specifications will be met in the casting.

When new and unusual design problems arise in the selection of metal and the casting of parts, you will find that the skill and integrity of your foundry is your best insurance that specifications—and delivery schedules —will be met.

GRAY IRON • ALLOYED IRON • MEEHANITE® • DUCTILE (NODULAR) IRON • NI-RESIST • DUCTILE NI-RESIST • NI-HARD

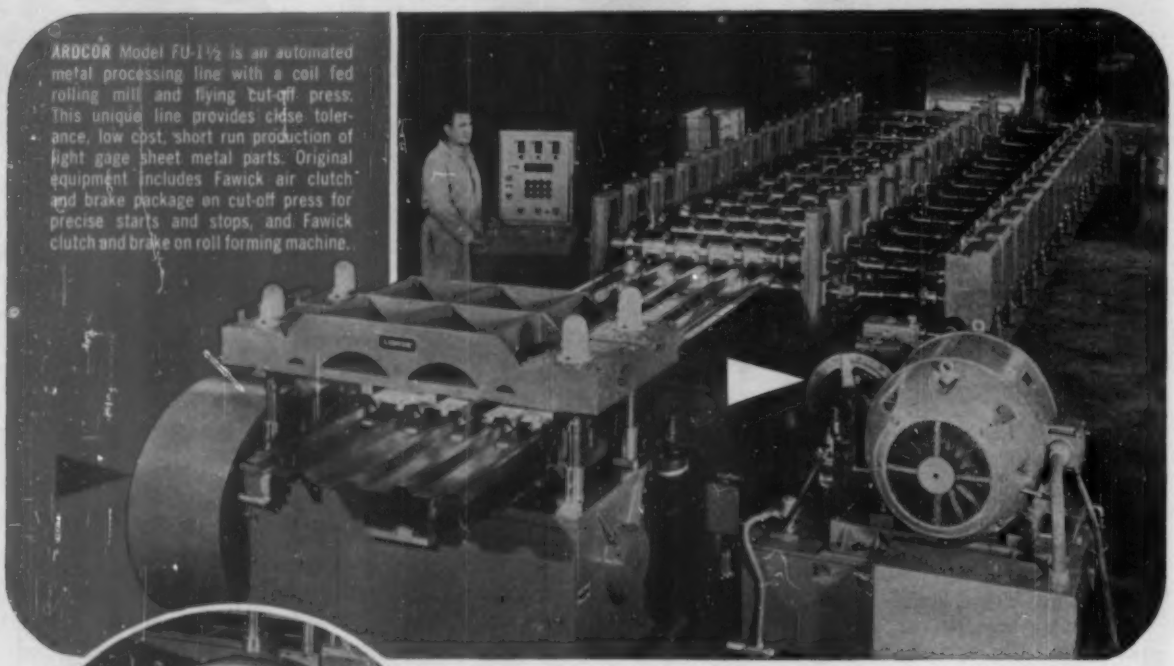
HAMILTON FOUNDRY INC.

1551 LINCOLN AVENUE • HAMILTON, OHIO • TWinbrook 5-7491

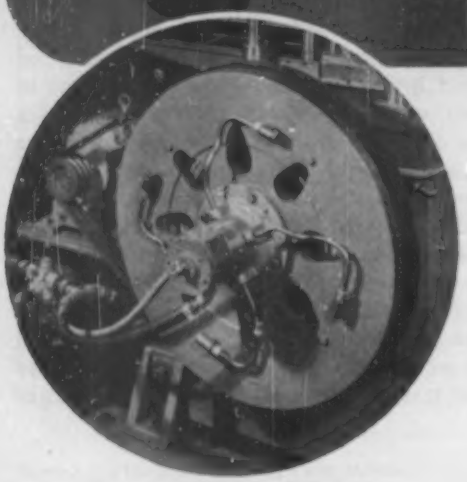
Circle 392 on Page 19

DESIGN FOR CONSISTENT ACCURACY IN REPETITIVE OPERATIONS

...with Fawick air clutch and brake packages



ARDCOR Model FU-1½ is an automated metal processing line with a coil fed rolling mill and flying cut-off press. This unique line provides close tolerance, low cost, short run production of light gage sheet metal parts. Original equipment includes Fawick air clutch and brake package on cut-off press for precise starts and stops, and Fawick clutch and brake on roll forming machine.



FAWICK AIR CLUTCH AND BRAKE PACKAGE assures precise starts and stops in flying cut-off operation of new ARDCOR system. Accurate positioning is maintained every cycle at speeds from 40 to 240 fpm.

FAWICK air clutches and brakes have the built-in combination of precise control and reliability you want in designing modern cyclic machinery.

American Roller Die Corporation, Wickliffe, Ohio, recently designed these benefits into their new sheet metal processing unit, shown above. In this integrated coil-fed forming line, finished product accuracy depends on the cut-off press at the output end of the rolling mill. ARDCOR selected a FAWICK clutch and brake package to start and stop the flying cut-off machine.

Result: the Fawick units, automatically cycled through digital electronic control, assure a typical cut-to-length accuracy of 20 feet ± 1/16 inch at 150 fpm.

This is just one instance of FAWICK ability to insure successful operation of new designs. For specialized advice on *your* problem in mechanical power transmission, consult your nearest FAWICK Representative or the Home Office.

FAWICK AIRFLEX DIVISION
FAWICK CORPORATION
9919 CLINTON ROAD • CLEVELAND 11, OHIO
Fawick Canada, Ltd., 60 Front St., West, Toronto, Ont., Canada

FAWICK AIRFLEX
INDUSTRIAL CLUTCHES AND BRAKES

Circle 393 on Page 19

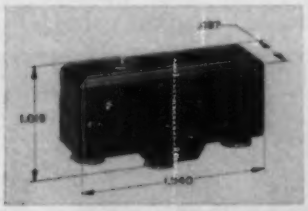
Line includes 13 sizes, with discharges from 1 to 5 in. Standard units are designed for 120 psig and temperatures of 40 to 250 F. **Buffalo Pumps Div., Buffalo Forge Co.,** 490 Broadway, Buffalo 5, N. Y.

Circle 707 on Page 19

Steady-State Switch

22-amp unit handles up to 35-amp inrush currents

Type M steady-state, 22-amp capacity switch is a sensitive unit which handles up to 35-amp inrush currents. Unit has a snap-acting,



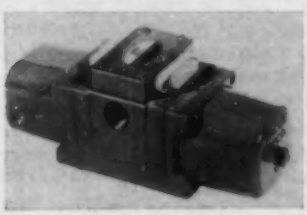
beryllium-copper spring mechanism inside a molded-phenolic case. Moving serrated-silver contacts produce high contact pressures, reduce contact resistance, cut through films on the contacts, and break welds caused by overload. Switch has 0.001-in. maximum differential travel and 0.005-in. minimum overtravel. Either stranded or solid wire connects to the terminals. Switch is rated at 22 amp at 125, 250, or 480 v ac; ¼ hp at 125 v ac; or ½ hp at 250 v ac. **Micro Switch Div., Minneapolis-Honeywell Regulator Co.,** Freeport, Ill.

Circle 708 on Page 19

Hydraulic Valve

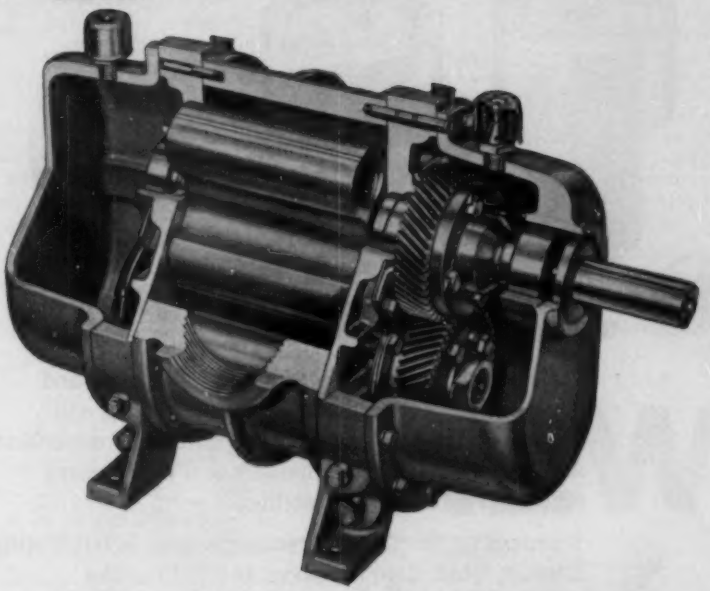
incorporates light to indicate application of power

Sentinel Light indicates when power is being applied to a solenoid, and is available on ⅛, ⅜, and ¾-in., 3000-psi, solenoid-controlled valves. It can also be added to any



NEW

M-D Standard Duty Blowers-Series 16



Engineered specifically for pneumatic conveying applications

The new Standard Duty M-D Rotary Positive Blower Series 16 combines all of the ruggedness and dependability of ductile iron with the flexibility, lighter weight and lower cost of aluminum blowers.

Eleven models ranging from 50-4000 CFM of air with pressures up to 12 PSIG or up to 12" HG vacuum have been specifically designed for material handling system applications.

Send us your air or vacuum requirements. We'll be glad to make recommendations.

For full information, write

M-D BLOWERS, INC.

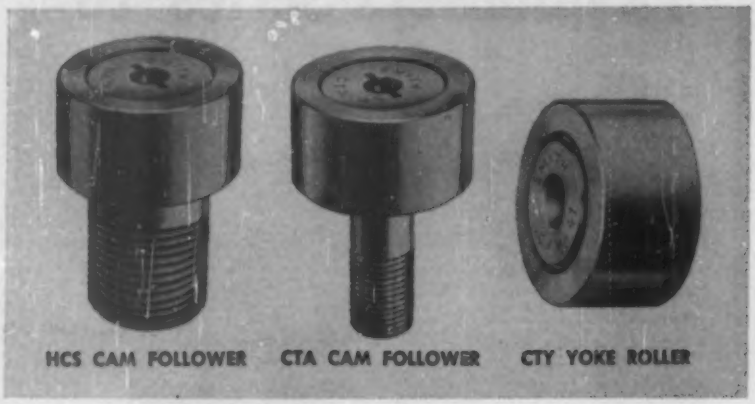
Racine, Wisconsin

A SUBSIDIARY OF MIEHLE-GOSS-DEXTER, INC.

Circle 394 on Page 19

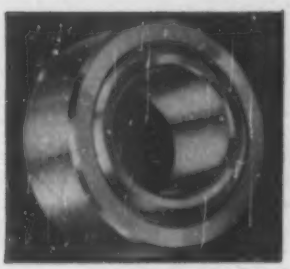
SMITH cam followers and yoke rollers

engineered to precise standards



Each component of every Smith Cam Follower and Yoke Roller is carefully engineered, machined and finished to the most exacting standards and dimensions. As a result, Smith Cam Followers and Yoke Rollers perform with uniform reliability.

Standard Smith "CTA" (interchangeable) or "HCS" (High Capacity Stud) Cam Followers and "CTY" Yoke Rollers will give you outstanding performance with long, trouble-free life.



Smith/Align Bearings are new self-aligning bearings that are specifically designed for applications which are extremely critical—where dependable performance is vital and failure too costly to tolerate. Smith/Align Bearings will function smoothly, without bind, yet with as little as .0002" clearance between ring and ball.

Better distributors throughout the country stock and sell Smith Cam Followers and Yoke Rollers.

Write for the handy, quick reference data sheets on Smith Cam Followers and Yoke Rollers and for full information on Smith/Align Bearings.

Smith Bearing Division / Accurate Bushing Company

441 North Avenue, Garwood, New Jersey

Manufacturers of: Needle Bearings, Cam Followers, Yoke Rollers, Jet Engine After Burner Rollers and Bearing Assemblies, Airframe Standard and Special Bearings, High Temperature and Severe Wear Precision Parts.

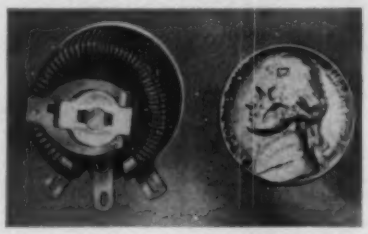
of these valves already in use or in stock. Light can also spot immediately if opposing solenoids are being energized simultaneously. It is a neon bulb and properly sized resistor to insure long life. **Racine Hydraulics & Machinery Inc.**, 2000 Albert St., Racine, Wis.

Circle 709 on Page 19

Miniature Rheostat

has high power-handling capability

Model E 12½-w miniature rheostat is available with tapered windings on special order. Rheostat, ⅞-in. diam and extending only 11/16 in.



behind the mounting panel, has ceramic hub, independent contact-arm pressure, vitreous-enamel coating, and metal-graphite contact. It has high power-handling capability. **Ohmite Mfg. Co.**, 3645 Howard St., Skokie, Ill.

Circle 710 on Page 19

The following item corrects one originally run in our Sept. 28 issue, in which the weight of the unit was given in error as 30 rather than 13 oz.

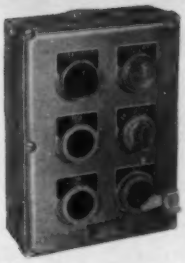
Slide Valve

midget solenoid unit is for pressures to 1400 psi

Small solenoid valve can be used as a two, three, or four-way unit; operation is based on the slide-valve principle. Dc solenoids for either 6, 12, or 24 v with a power consumption of 5 w are available. Valve can be used in systems with up to 1400 psi working pressure. It has a response time of approximately 40 millisec. Size of the valve is 1.3 x 1.3 x 2.5 in., and weight is 13 oz. It is for ⅛-in. pipe size. **Herion Inc.**, Box 184, Valley Stream, N. Y.

Circle 711 on Page 19

NEW



Oil-Tite pushbuttons

Simple, rugged, contamination-proof. Flush oil-tite pushbuttons with minimum projection keep oil, coolant, cutting oil or water from contacts. Wide variety of head types and interchangeable color caps make this one of the most flexible lines of pushbuttons available today. Write for Bulletin B-7321, Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. *You can be sure . . . if it's Westinghouse.*

J-96166

Westinghouse

Circle 396 on Page 19

NEW



STATIC SLIPSYN synchronous motor control

No moving parts, precise synchronizing control up to 99% of synchronous speed. Static networks eliminate corrosion and wear failures. Positive adjustable pull out protection avoids false tripping. Static damper winding, field loss and incomplete starting sequencing protection available. For new or old motor control installations. For details, write Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. *You can be sure . . . if it's Westinghouse.*

J-96186

Westinghouse

Circle 397 on Page 19

ENGINEERING DEPARTMENT

EQUIPMENT

Vacuum-Tube Voltmeter

has frequency response from 10 cps to 500 kc, ±1 db

No. IM-21 ac vacuum-tube voltmeter has extended frequency response from 10 cps to 500 kc ±1 db, and 10-megohm input impedance for high accuracy. Circuit design features a cathode follower stage on all ranges for increased input impedance, and two-stage amplifier with approximately 19 db of negative feedback to insure high output stability and linearity. With 10 megohms input impedance, circuit under measurement will be virtually unaffected. Meter covers 0.01 to 300 v rms full-scale in ten ranges. A



calibrated scale permits measurement of db from −50 to +50 in ten ranges with 10-db steps between ranges. Unit is available either in kit form or already assembled. Heath Co., Benton Harbor, Mich.

Circle 712 on Page 19

Transistorized Oscilloscopes

for medium to high-frequency range

Types 746 and 766 oscilloscopes utilize simultaneously two plug-in circuits in which only transistors or miniature Nuvistors are used. Type 766 accepts all plug-ins already developed or being designed. Preliminary specifications indicate a

IF you manufacture:

air conditioning
appliances
electronics
communications
electrical apparatus
fans
blowers
machine tools
materials handling
panelboards and switch boards
prime movers
pumps
compressors
general machinery

these Westinghouse products are tailored for you

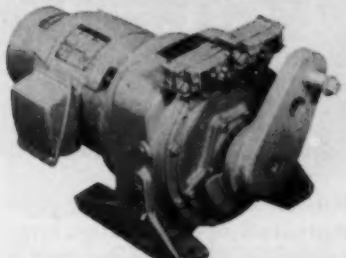
On these pages are shown some of the many components developed and manufactured by Westinghouse specifically for OEMs. Here is one single source for technical assistance, manufacturing and stocking of all of your electrical needs. Use this *total* service to solve your design and manufacturing problems now. Call your local Westinghouse Sales Engineer or write Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. *You can be sure . . . if it's Westinghouse.*

J-96163-R

Westinghouse

Circle 398 on Page 19

NEW



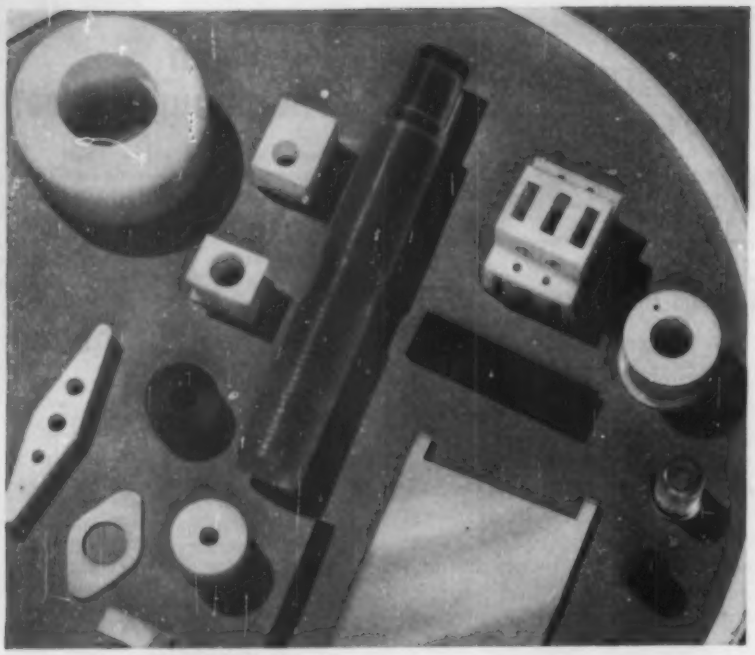
Guardistor*-protected Moduline Motocylinder*

Motocylinders for materials handling jobs replace steam and air cylinders—are protected against burnout from any cause. Available in 1 to 20 hp. sizes, 8 to 24 inch stroke, 22, 41 and 61 crank rpm. Write to Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. for Bulletin AD-3760. *You can be sure . . . if it's Westinghouse.* *Trademark

J-96187

Westinghouse

Circle 399 on Page 19



FABRICATING
is another Polymer EXTRA!



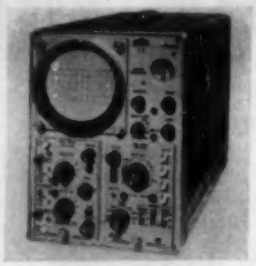
Polymer's complete service in industrial plastics includes fast, expert fabrication help when you need it. Since 1950, more and more users of POLYPENCO® plastic forms have found Polymer's Fabricated Parts Service saves time and money in machining, stamping or forming industrial plastic components.

This is particularly true of intricate, close-tolerance parts which may require special attention and strict quality controls. Polymer's broad experience in materials selection, design, prototype development and fabrication all work in your favor.

For details, call your Polymer representative or write for new brochure BR-110.

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bandwidth approaching the 25-megacycle range. Type 746 accepts only the 74 series plug-ins; nominal bandwidth is 5 megacycles. The 746 oscilloscope has a 10 x 10-cm display area with equal x-y capability, while the 766 features a 5 x 10-cm display. **Allen B. Du Mont Laboratories, Div. Fairchild Camera & Instrument Corp., Clifton, N. J.**

Circle 713 on Page 19

Modular Power Supplies

operate at full ratings without heat sink to 35 C

Modular transistor-regulated power supplies for laboratory and prototype work can be operated at full ratings without heat sink at up to 35 C ambient temperature. Mounting-base temperature is 65 C. Packages use all-semiconductor circuits and operate isolated from the ac line, providing adjustable output. They are short-circuit protected by current limiting, and provide auto-



matic recovery after short removal. Power supplies are available in a full line of specifications ranging from 4.5-6.0 v to 45-55 v. **Power Sources Inc., Northwest Industrial Park, Burlington, Mass.**

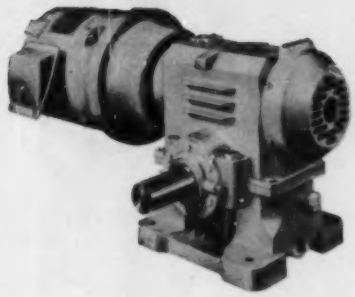
Circle 714 on Page 19

Event Recorder

operates more than 50 days without chart change

No. 620 Event Recorder with Tem-

NEW



worm gearmotors

More torque for your money. Higher output torque for given input h.p. Meets all AGMA standards. Available in 1–20 h.p. range, ratios 5:1–70:1. Can be floor, ceiling, wall or vertically mounted. For B-8285 write to Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. *You can be sure . . . if it's Westinghouse.*

J-96192

Westinghouse

Circle 401 on Page 19

NEW



Adjustiflow drive

Dual cooling system reduces belt wear . . . key to longer belt life. Liberal overload capacity—full rated h.p. at the output shaft. For more information write Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. *You can be sure . . . if it's Westinghouse.*

J-96193

Westinghouse

Circle 402 on Page 19

pen is available in both a 10-channel model and a 20-channel unit. Recorder can operate more than 50 days without a change in charts. Electrically heated, stainless-steel styluses provide "yes-no" or "on-off" information on special paper. Power to heat the styluses can be obtained from a 120-v, 50 to 60-cycle source, or from a 12-v storage battery. Accessible rheostat can be set to control the width of lines made by the styluses. Unit can be ordered with a variety of chart drives—synchronous motor, selsyn, and phantom. Available chart speeds range from ¾ iph to 6 ips. All charts are 80 ft long and have rectilinear co-ordinates ar-



ranged so that the occurrence of events can be timed easily. **Esterline Angus Instrument Co. Inc.,** P. O. Box 596, Indianapolis 6, Ind.

Circle 715 on Page 19

Direct-Recording Oscillograph

has 24 channels in 7-in. rack height

Model 1508 Visicorder is a direct-recording oscillograph which fits 24 direct-recording channels into 7 in. of rack height. Channels are recorded on 8-in. wide paper, with each channel capable of recording individual static or dynamic phenomena at frequencies from dc to 5000 cps. All operating controls are on the front panel of the instrument, and any of 12 recording speeds can be selected before or during recording by means of pushbutton controls. Deflection of 8 in., peak to peak, is possible, and traces are recorded at writing speeds in excess of 50,000 ips. Instrument produces instantly readable records without the use of chemical or darkroom processing. Light source is a high-pressure, mercury-vapor lamp with

NEW



BF relay

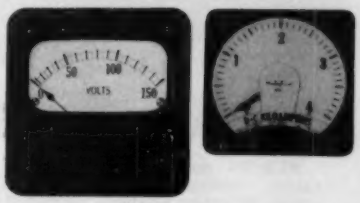
Saves space, cuts cost, is specially engineered for machine tools. 50% less space, front accessible terminals, low temperature operation, lower installed cost, long life. In both 4-pole and 8-pole frames, rated at full load current of 6 amps/300 volts a-c 60 amp inrush. Write for Bulletin B-7345, Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. *You can be sure . . . if it's Westinghouse.*

J-96165

Westinghouse

Circle 403 on Page 19

NEW



*tbt** switchboard instruments

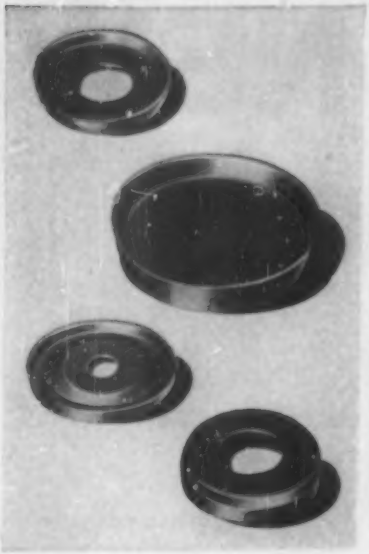
No friction, higher sensitivity, infallible repeatability, unaffected by shock or vibration (can be shipped installed in equipment). These new Westinghouse K-241 and K-251 Taut Band Suspension instruments available in 4½" full view 250° scale or 6" rectangular 100° scale designs. Meet or exceed ASA Standard C-39.1. For sample of TBS and Bulletins 43-240 and 43-250, write Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. *You can be sure . . . if it's Westinghouse.*

J-96181

*Trademark

Westinghouse

Circle 404 on Page 19



RULON — first practical fluorocarbon for cup packings

Dixon's new post-forming technique makes use of Rulon's plastic memory to insure tight seals under all conditions . . . at lower cost than ever before!

Packings of Rulon (filled TFE) give you: (1) low friction, (2) high resistance to wear, (3) low deformation under load (⅓ that of Teflon*), (4) wide temperature tolerance (−400° to +500°F), (5) chemical inertness, (6) lube free operation, and (7) zero water absorption.

Dixon offers RULON and TEFLON in

- rods
- tubing
- sleeving
- sheet
- tape
- extruded shapes
- bearings
- bushings
- washers
- gaskets and packings
- bearing retainers
- machined and molded parts

RULON now serves in pumps, valves, motors, compressors and scores of other products manufactured by leading companies across the nation. Dixon offers the widest variety of basic shapes, both in RULON and Teflon . . . plus engineering capability to formulate special reinforced fluorocarbons for special needs. Also, Dixon can supply molded, machined, stamped, cut or extruded parts to meet your print.

See our guide-book on RULON, Bulletin #9572, in Sweet's Product Design File or send details for recommendations. DIXON CORPORATION, 100 BURNSIDE ST., BRISTOL, R. I.



* DuPont T.M.

DIXON

Circle 405 on Page 19



maximum output in the ultraviolet region. **Heiland Div., Minneapolis-Honeywell Regulator Co.**, 5200 E. Evans Ave., Denver 22, Colo.

Circle 716 on Page 19

Filing Cabinet

accommodates material measuring 17 x 22 in.

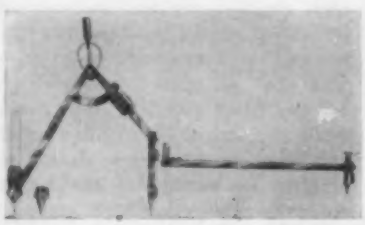
Pro-File cabinet is available for heavy-duty use, with built-in, reinforced, multiwall construction, permanent suspension rails, detachable cover for ease of access and flush, built-in handles. Each of the 75 self-contained file envelopes included with the cabinet is 17 by 22 in. size, and has laminated to it a sturdy, die-cut handle and hanger. Self-adhesive identification labels are furnished. **Clarkson Co.**, Kaukauna, Wis.

Circle 717 on Page 19

Compass; Beam Attachment

for use with Rapidograph drawing-point sections

No. 3175 Rapidograph-Compass is a ringhead-bow unit with a quick-setting device. It can be used with either the Rapidograph drawing-point sections or with graphite leads. Beam attachment 3175-B, for making large circles, assures uninterrupted completion of largest circles because of the ample ink supply in the Rapidograph ink reservoir. **Koh-I-Noor Inc.**, Bloomsbury, N. J.



Circle 718 on Page 19

QUALITY TESTED 97 TIMES



PRECISION TUBING

When you specify Precision Tubing, you can depend upon quality material and quality workmanship . . . both checked and rechecked more than 97 times from receipt of base stock to the boxing of your order. Skilled technicians and qualified engineers check every operation using the finest laboratory equipment available. The chemistry of the metal itself is scrutinized; even the grain size is photomicrographed. Finally, Precision's exclusive "Electro-Scan" process is put to work, electronically testing for any hidden defects in the finished tubing.

Ninety-seven reasons why you can eliminate anxious moments—specify Precision Tubing. For complete details on Precision Tubing write to. . . .

PRECISION TUBE CO., INC.
North Wales, Pa.

PRECISION
TESTED BY ELECTRO-SCAN

Circle 406 on Page 19



Increase efficiency in "stop-and-go" actions with J-M **MINI-BLOKS®**

LET A J-M FRICTION SPECIALIST HELP YOU SOLVE COMPLEX PROBLEMS WITH TOUGH LITTLE FRICTION ELEMENTS, CUSTOM-DESIGNED TO YOUR EXACT NEEDS.

When it comes to improving performance, your Johns-Manville Friction Specialist is a good man to know. He is an expert in the design of small friction parts – many featuring unitized construction – that increase "stop-and-go" efficiency.

At his command is a wide range of asbestos-based materials, especially developed by J-M, in compositions that meet virtually any requirement.

If, for example, you need drive clutches, torque limit clutches or small brakes – J-M MINI-BLOKS are made of ideally suited materials. MINI-BLOKS can be precision-molded to close tolerances. They offer a range of frictions and densities, along with high temperature resistance and long, trouble-free service life.

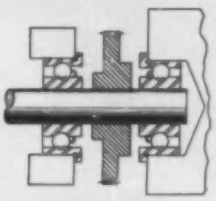
ANTI-FRICTIONS TOO! Also available from Johns-Manville are self-lubricating bearings and bushings of DRI-SLIP® for dry application or EEL-SLIP® for moist or fluid conditions . . . precision-molded and machined to your exact needs.

Just tell the J-M Friction Specialist the part you need and the characteristics you require. He'll take it from there. Or for a free copy of a new 24-page book on all J-M Friction materials, ask for FM-57A. Write to Johns-Manville, Box 359, New York 16, N. Y. In Canada: Port Credit, Ont. Cable: Johnmanvil.

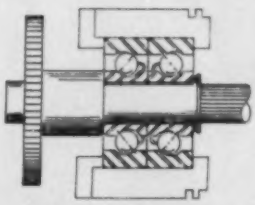
JOHNS-MANVILLE

No. 3

ideas you can use in working with bearings



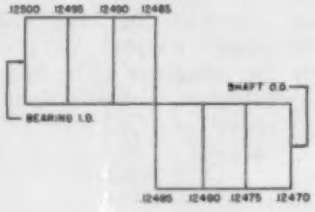
The use of flanged bearings can reduce expense in servomechanism gearing, especially where plate or cantilever construction is involved. The flange eliminates the need for bearing retainer plates and also makes it possible to blind depth bore to non-critical depths. The blind hole can be used as a lubricant reservoir to retain grease.



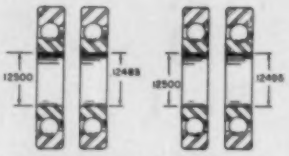
The output shaft bearings in gear heads are usually preloaded to reduce backlash. Pairs of bearings, preloaded to a specific value by the bearing manufacturer, offer two advantages. Variation in preloading during assembly is eliminated which means more consistent torque and end shake values from unit to unit. Secondly, assembly time is reduced. Where required, the advantages of preloaded bearings can justify their additional cost.



A bearing which has become magnetized will attract stray metallic particles which can work their way on to raceways or balls with disastrous effects on bearing performance. Although all New Hampshire bearings are carefully demagnetized before final washing and packaging, it is possible for them to be re-magnetized during shipment if they are placed in strong magnetic fields. A good precaution is to perform final demagnetization before installing bearings in their final assemblies.



Interference fitting tighter than line to line is not recommended by New Hampshire for the majority of applications. The block diagram above shows this fit achieved by coded selection. The bearing I.D. is represented by the top blocks and the shaft O.D. by the lower blocks. The bearing I.D. represents a tolerance of .00015" with a similar tolerance for the shaft. A resulting fit of line to line to .0003" loose is shown.



ABEC CLASS 7 BEARINGS WITH STANDARD BORE TOLERANCES OF .0001" AT EXTREMES OF BORE TOLERANCE

ABEC CLASS 7 BEARINGS WITH BORES CODED IN .00005" INCREMENTS AT EXTREMES OF BORE TOLERANCE.

In high accuracy designs where bearings must be as close together as possible (e.g. bevel gear differentials) shaft to inner race fit is vitally important to assure as much radial stability as possible under these conditions. Even two ABEC Class 7 bearings would not provide a sufficiently precise fit should their bores be at the extremes of tolerance (.00015"). However, bearings may be specified with bores coded in .00005" increments.



150-page Design and Purchasing Manual is the most comprehensive treatise on miniature and instrument ball bearings ever published. Qualified design and specifications engineers, and procurement specialists, are welcome to a copy.

NHBB FLANGED RETAINER BEARINGS

BORE	O.D.	WIDTH	BEARING NUMBER	FLANGE DIAMETER	FLANGE WIDTH	RADIUS	C RATING
.0469	.1562	.0625	SFR0	.203	.013	.005	19
.0550	.1875	.0781	SFR1	.234	.023	.005	28
.0781	.2500	.0937	SFR1-4	.296	.023	.006	39
.0937	.1875	.0625	SFR133	.234	.018	.005	21
.0937	.3125	.1094	SFR1-5	.359	.023	.006	64
.1250	.2500	.0937	SFR144	.296	.023	.005	36
.1250	.3125	.1094	SFR2-5	.359	.023	.006	66
.1250	.3750	.1094	SFR2-6	.422	.023	.006	66
.1250	.3750	.1562	SFR2	.440	.030	.012	73
.1562	.3125	.1094	SFR155	.359	.023	.005	35
.1875	.3125	.1094	SFR156	.359	.023	.005	35
.1875	.3750	.1250	SFR166	.422	.023	.008	82
.1875	.5000	.1960	SFR3	.565	.042	.012	137
.2500	.3750	.1250	SFR168	.422	.023	.006	44
.2500	.5000	.1250	SFR188	.547	.023	.010	120
.2500	.6250	.1960	SFR4	.690	.042	.012	170
.3125	.5000	.1562	SFR1810	.547	.031	.009	60

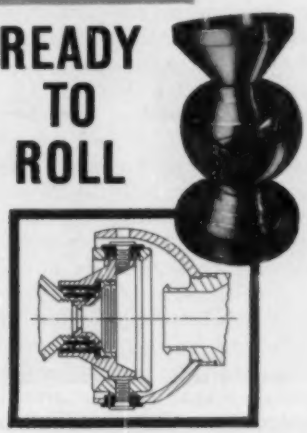
NEW HAMPSHIRE BALL BEARINGS, INC.

PETERBOROUGH, N. H.

Circle 408 on Page 19

Instrument sub-assemblies complete with precision-fitted miniature or instrument ball bearings

READY TO ROLL



If you have a problem making or obtaining some of the proper components for instrument bearing sub-assemblies — or if you have trouble fitting them together with the required precision — you should investigate the services of the Rotassembly Division at New Hampshire.

In this separate facility, assemblies including bearings, shafts, housings and pulleys are produced to your designs, to New Hampshire precision standards and shipped to you inspected, tested and ready to install.

Manufacture is restricted to mechanical units in which the correct installation and performance of bearings are important and critical elements of the assembled unit. We are not manufacturers of or qualified to produce gears, gear trains, gear boxes, motors or electrical components.

For more complete information, write for Rotassembly Bulletin.

NEW HAMPSHIRE BALL BEARINGS, INC.
PETERBOROUGH, N. H.

THE ENGINEER'S

Library

Recent Books

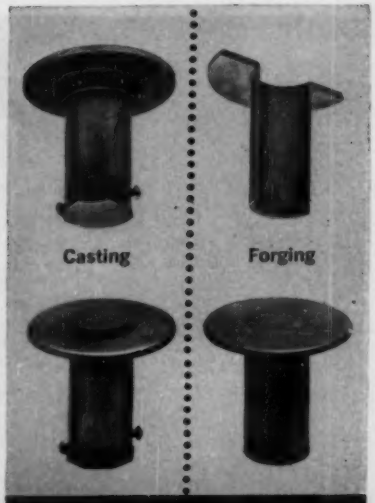
Techniques of Value Analysis and Engineering. *By Lawrence D. Miles; 267 pages, 6¼ by 9¼ in., clothbound; published by McGraw-Hill Book Co., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN, *$8.50 postpaid.*

The specific techniques of value analysis are presented to identify unnecessary cost in all stages of the product cycle—design, during design, during manufacturing, etc. All phases of product design, engineering, manufacturing, and quality control are discussed. Also covered are the procedures to be followed in establishing a value-analysis department in any industry. Other chapters discuss the actual work content which must be accomplished for effective value-engineering and measurements and tests which establish the degree of value practices and value work. Numerous problems and case histories are included.

The Servo Engineer's Handbook. *Edited by Harry P. Bridge Co.; 128 pages, 6 by 9 in., paperbound; published by Daystrom Inc., Transicoil Div., Worcester, Pa.; $3.00 per copy.*

To aid the practicing servo engineer in his day-to-day work, the overall treatment of this handbook is practical rather than theoretical. The first chapter is an introduction to show how the different components are related. Five succeeding chapters deal with motors, rate generators, synchros, gear trains, and amplifiers. A separate chapter describes how these are assembled into a co-ordinated system for optimum control. The final chapter describes component development to meet various environment conditions.

Soviet Research on Gravitation. *By Maurice A. Garbell, Garbell Research Foundation; 380 pages, 8 by 10¼ in., paperbound; distributed by U. S. Department of Commerce, Business and Defense Services Administration, Office of Tech-*



15 STEPS ELIMINATED

by BRIDGEPORT'S new Cored Forging Method

Originally, a casting requiring heavy cutting, a tube, a web plate and 3 rivets were required. Now a one-piece brass cored forging is polished and plated without machining—and the blanked out web provides the cap.

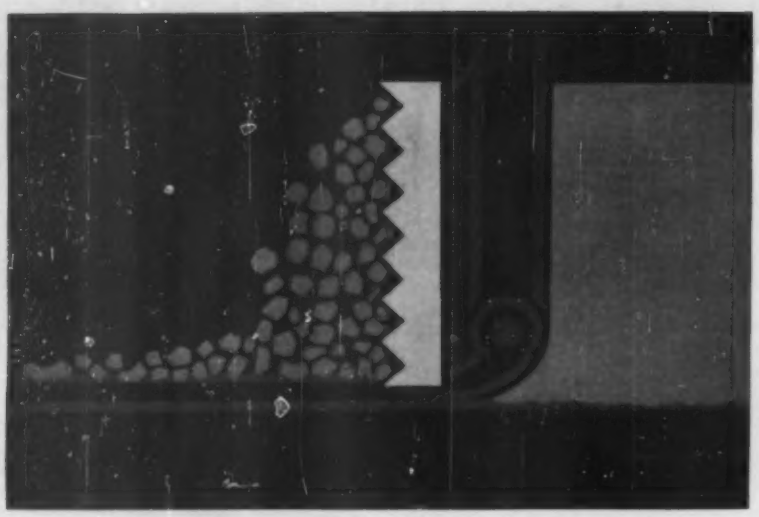
This stanchion socket benefits from 5 common Cored Forgings advantages.

✓	no draft, I.D. or O.D.
	denser, stronger grain
✓	less machining to finish
✓	less assembly required
	thinner walls or sections
	better appearance
	multiple coring
✓	lower cost plating
✓	less scrap/rejects

Which of these process savings or product improvements would apply to *your* part or assembly? Write for descriptive brochure...or send your parts or drawings for our evaluation...to:

CORED FORGINGS DIVISION
BRIDGEPORT BRASS COMPANY
1000 Connecticut Ave., South Norwalk, Conn.

Circle 409 on Page 19



What wears out in your plant?

Where a combination of corrosion and abrasion causes parts to wear out fast, a series of Kennametal* hard carbide alloys provide resistance to corrosion nearly that of the noble metals . . . while possessing far greater resistance to wear than these more expensive metals. In the wide range of Kennametal hard carbide compositions you will find high resistance to corrosion, abrasion, bending, impact, and heat . . . plus high hardness and strength.

Consistent research and development have opened diversified markets for Kennametal . . . so it is now used extensively as a material of construction for vital machine components and wear-spot applications in practically every industry. Some typical applications are sealing rings, balls and seats, sleeve inserts, spray nozzles, cones, needle valves, metal cutting inserts, cutter bits and drills for mining.

There is a good chance that Kennametal can help reduce maintenance and production costs in your plant or add life to vital components in products you make. Our facilities are available to help tranalate ideas into products that will combine reliability with long service.

For additional, useful information about Kennametal hard carbides, write to KENNAMETAL INC., Dept. MD, Latrobe, Pennaylvania.



INCREASES SERVICE LIFE 4 TO 1. Kennametal unloader knives or scrapers, on a crystal dehydrator, increased service life to 12 months in processing highly corrosive ammonium sulfate and to 4 months in processing synthetic sulfate... a service ratio of 4 to 1, in eech process, compared with knives previously used.

*Trademark

KENNAMETAL Inc.

nical Services, Washington 25, D. C.; $5.00 per copy.

The current state of research in the field of gravitation in the Soviet Union, and Soviet capability to utilize or modify natural gravitational phenomena, were surveyed and evaluated by the Garbell Research Foundation under a contract sponsored by the Air Information Division of The Library of Congress. Extensive general references and bibliographies are included.

Kinematics and Design of Mechanisms. *By Alexander Cowie; 449 pages, 6¼ by 9¼ in., clothbound; published by International Textbook Co., Scranton 15, Pa.*

This book presents up-to-date methods for the analysis and design of cams, gears, and linkages. Its approach to kinematic analysis emphasizes the point path and position vector, and does not require a complicated notion. Development and application of the Euler-Savary equation for point-path curvature and the inflection circle are covered as well as a complete analysis of contact velocities and their relation to wear phenomena in direct-contact mechanisms. Chapter titles include instantaneous centers of velocity, acceleration, and curvature; direct contact mechanisms; spur gears; helical, worm, and bevel gears; gear trains; cams; linkage design; and special-purpose mechanisms.

The Handbook of Thermophysical Properties of Solid Materials, 5 Volumes. *Edited by Goldsmith, Waterman, and Hirsehorn; 4300 pages, 8¾ by 11¼ in., clothbound; published by The Macmillan Co., 60 Fifth Ave., New York 11, N. Y.; $90.00 per set.*

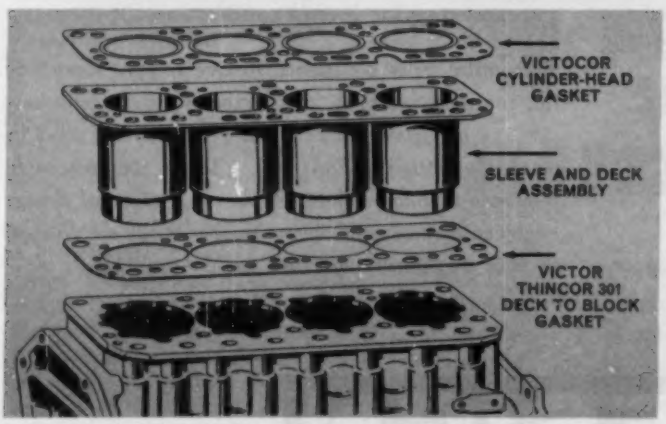
This handbook is a collection of all known data on twelve important physical properties of solid materials. Five properties of the twelve covered—density, melting point, latent heat of fusion, latent heat of vaporization, and latent heat of sublimation—are grouped together for convenience on single data sheets. The seven other properties—specific heat, thermal conductivity, thermal diffusivity, emissivity-reflectivity, linear thermal expansion, vapor pressure, and electrical resistivity—are evaluated on separate data sheets and plotted on separate graphs as functions of temperature. Materials in-

JOHN DEERE

"NEW GENERATION OF POWER"

SEALED PRECISELY TO SPECIFICATION BY VICTOR





EXPLODED, PARTIAL ENGINE VIEW showing sequence of block to cylinder-head gasket assembly. The critical cylinder-deck to block seal is made with Victor THINCOR 301, the thinnest, metal-supported, tight-sealing gasket available today for preventing distortion of mating parts.

New THINCOR 301 Gasket Holds Vital Deck-to-Block Seal on Unique Deere Engine

Thousands of working John Deere tractor Models 1010 and 2010 certify this case history—a typical example of Victor gasket development for exacting power sealing. The power unit, Deere's distinctly new sleeve and deck diesel, is also built for gasoline or LP fuels.

The most critical seal—cylinder deck and block assembly—is held tight by a *THINCOR 301* gasket under these conditions: extreme dynamic loading—high temperatures—large exposure to coolant—small contact areas. *THINCOR 301* is *Victopac®*, mechanically bonded to a perforated thin steel layer to resist gasket extrusion. The steel side is precoated with high-temperature aluminum sealant.

The cylinder-head gasket helping these engines deliver full-rated power is *Victocor®*. This highly compressible and resilient thin steel core gasket is widely specified for heavy duty.

Victor Oil Seals Specified

Front and rear crankshaft seals . . . wheel bearing seals . . . transmission, external and internal, and final drive assembly oil seals are among many Victor designs helping the performance of Deere 1010 and 2010 tractors.

Let's Get Our Engineers Together

With no obligation either way, Victor engineers are available for counsel on your sealing specifications. Your inquiry invited; also your request for latest engineering catalogs on Gaskets and Oil Seals. Victor Mfg. & Gasket Co., P.O. Box 1333, Chicago 90, Illinois.—Canadian Plant: St. Thomas, Ontario.



VICTOR Sealing Products *Exclusively*

GASKETS • PACKINGS • OIL SEALS • MECHANICAL SEALS

ANNOUNCING MACHINE DESIGN's 1962 BOOKS PROGRAM:

THE FLUID POWER BOOK
1-Power Components

THE ELECTRIC CONTROLS BOOK
Switches, Relays and Timers

THE PLASTICS BOOK

THE MECHANICAL DRIVES BOOK

The four books to be published in 1962 will again cover subjects of vital interest to design engineers and will follow the same, easy-to-use and entirely reader-oriented style that was developed for the very first one. Each will have a Design Data Section devoted to significant selection and application information.

The contents will be authored by experts in industry, in Universities and associations, and MACHINE DESIGN editors.

The second major section will consist of a Product Directory, developed through direct mail cooperation with manufacturers and producers to insure the latest and most complete listings possible.

This entire series is designed to give you the most useful, the most complete and current reference information on important materials and components used in every-day design of products. These comprehensive reference manuals belong on the desk of every design engineer. Make sure these valuable books are coming to your department and are readily available.

MACHINE DESIGN

BASIC REFERENCE MANUALS FOR DESIGN ENGINEERS

A Penton Publication, Cleveland 13, Ohio

cluded are elements melting above 1000 F (Volume 1), alloys (Volume 2), ceramics (Volume 3), and cermets, intermetallics, polymeric materials and composite materials (Volume 4). The fifth volume is a reference guide, listing sources of data. Authors are listed alphabetically and author and subject indices are cross-referenced.

British Miniature Electronic Components and Assemblies Data Annual 1961-62. *Edited by G. W. A. Dummer and J. Mackenzie Robertson; 479 pages, 8¾ by 11½ in., clothbound; published by Pergamon Press Inc., 122 East 55th St., New York 22, N. Y. $15.00 per copy.*

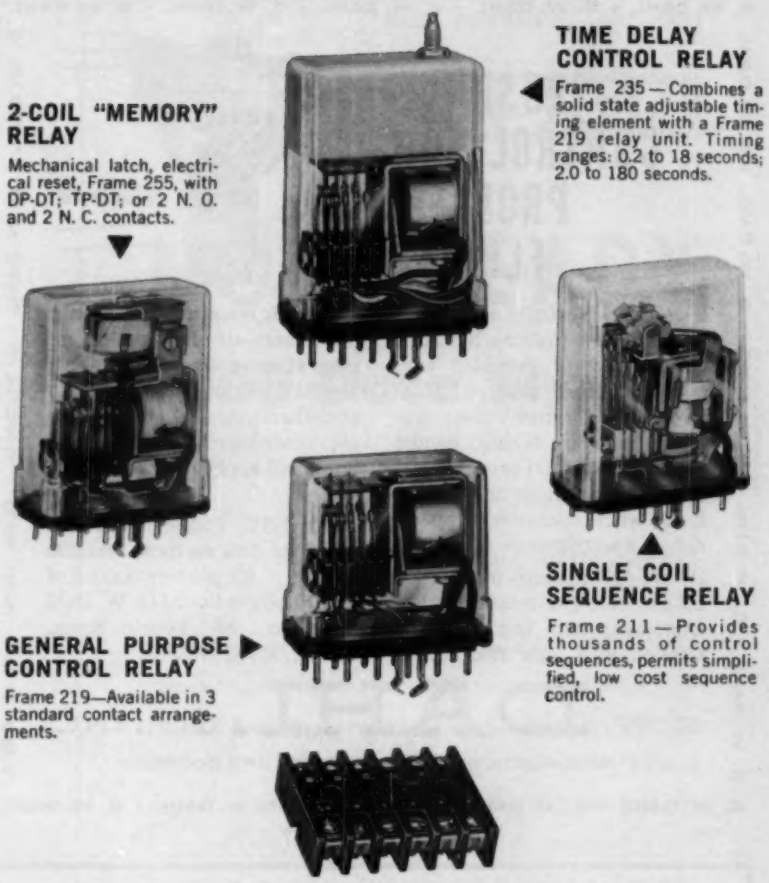
This is the first volume of an annual series. It contains essential data on a wide range of miniature components, and information on the effect of potting resins, shock, vibration, and temperature overload. A 1-in. cube is set as the maximum size for miniature components. Resistors up to and including the ½-watt rating are included, and for capacitors the maximum size limit of body length is approximately 1 in. Only British components, i.e. those manufactured or assembled in the U.K., are covered.

Patents for Management. *By Worth Wade; 72 pages, 6 by 9 in., paperbound; published by Advance House, P. O. Box 334, Ardmore, Pa.; $5.50 per copy.*

This handbook provides a working guide on patent law, pinpointing the areas where patent counsel is needed. Antitrust laws are discussed in a chapter on proper and improper use of patents. Patent rights of the employee and employer are covered in another chapter which includes a section on patent clauses in union contracts. Other chapters discuss profit from foreign patents, patents and taxation, and patents in public relations.

Graphics. *By John T. Rule and Steven A. Coons; 484 pages, 6¾ by 9½ in., clothbound; published by McGraw-Hill Book Co., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN, *$8.95 postpaid.*

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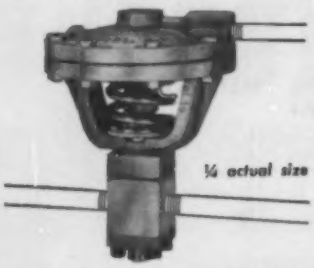
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place mathematical computation or augment it; and communication, in which the traditional engineering drawing is shown to be a language based on logical syntactical rules. Included are chapters on graphical calculus, together with new material on solution of differential equations, information flow diagrams, projective geometry, and periodic functions.

Magnetic Control of Industrial Motors: Part II. *By Gerhart W. Heumann;* 324 *pages, 6 by 9 in., clothbound; published by John Wiley and Sons Inc., 440 Park Ave., South, New York 16, N. Y.; available from* MACHINE DESIGN; $9.00 *per copy.*

In this application book, controllers for industrial type ac and dc motors are analyzed. Motor performance data for ac squirrel-cage, wound-rotor, and synchronous motors are presented as well as for dc series and shunt motors. This is accompanied by formulas for calculating performance when motors are used with different types of controllers. Principal circuits, selection of controller sizes and components, economic factors affecting controller selection, motor protection, and existing safety codes and standards are also covered. The book is presented in three parts. Part I is subtitled Ac Devices and Assemblies, Part II Ac Motor Controllers, and Part III Dc Motor Controllers.

Government Publications

OTS Technical Reports. Copies of reports listed below are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.

PB 151104. Design Information on Titanium Alloys for Aircraft and Missiles. By W. P. Achbach and R. J. Favor, Defense Metals Information Center, Battelle Memorial Institute; 84 pages, 8½ by 11 in., paperbound, stapled; $2.25 per copy.

Design allowables are summarized in this report for the commercially important titanium alloys. Strength properties are those commonly used in aircraft and missile design, such as tension, compression, bearing, and shear. Effects of low and elevated temperatures are included where available. Other factors influencing the selection of metals are included in comments preceding the specific properties of each alloy or alloy group.

TR R-116. Numerical Predictions of Radiative Interchange Between Conducting Fins with Mutual Irradiations. By Max A. Heaslet and Harvard Tomax, Ames Research Center, Moffett Field, Calif.; 56 pages, 8 by 10½ in., paperbound, stapled.

Analytical and numerical methods are developed that predict the flux of radiant energy from a family of thin, planar, conducting fins. A nonlinear integro-differential equation is derived and solved for a symmetrical array of fins, extending out from a common edge, conducting heat internally and radiating diffusely. Specific results are given for parametric variations of conduction, emissivity, fin geometry, and base temperature.

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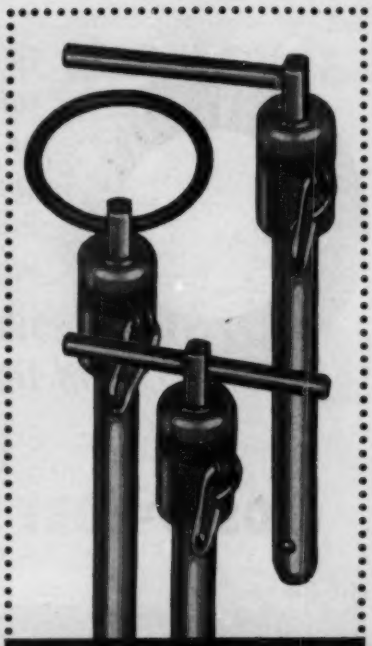
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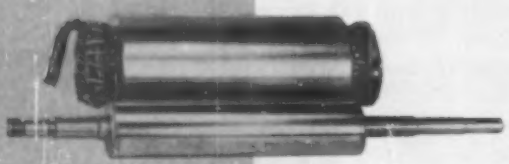


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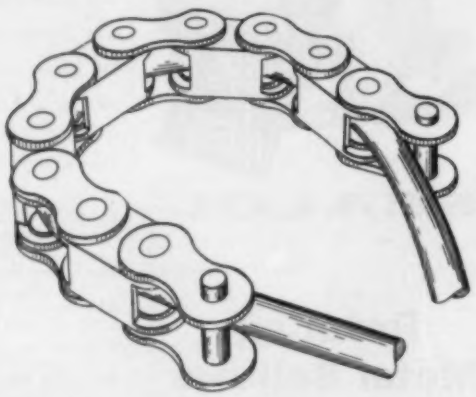
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Cable-Carrying Chain Assembly

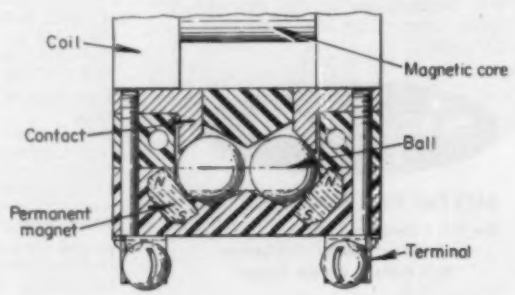
Box-type chain serves as a flexible, load-carrying connection between two electrical devices and provides a protected passage for wire or cable elements. The chain is made up of sections of rectangular tubing connected by flat-plate links. The box-type construction



provides a flexible chain assembly that can withstand torque or tension loads and prevents chafing or stretching of an electric cable passing through the center. *Patent 2,972,857 assigned to the United States of America (Secretary of the Navy) by Ralph H. Bodman.*

Ball-Contact Switch

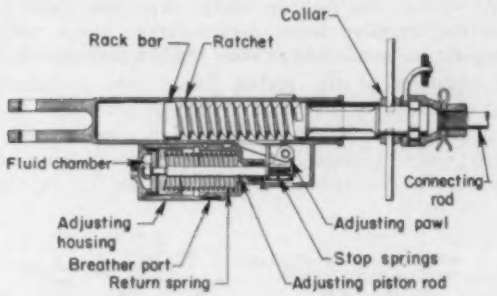
Electrical contact is made between two balls in a switching device, so that arcing or deterioration occurs at new areas on the ball surfaces in every switching cycle. Balls are normally held down by permanent magnets, but permanently engage the contact surfaces. To actuate the switch, an external magnetic field is supplied by a coil or permanent magnet. Magnetic circuit is completed through the electrically and magnetically conductive contacts, and through the balls. The balls roll up the sloping contact surfaces and contact to com-



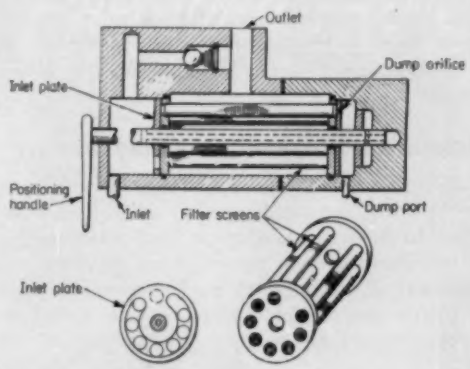
plete the circuit. *Patent 2,995,635 assigned to Tann Corp., Detroit, Mich., by Stanford R. and Herbert C. Ovshinsky.*

Automatic Slack Adjuster

Slack in a linkage or brake rigging can be taken up either automatically or manually. Manually operated, a rack bar with a helical screw is rotated by a collar with spokes, moving the telescoping members together. In automatic operation, fluid pressure from a brake cylinder is fed into the fluid chamber to move the adjusting piston rod. If stroke is sufficient, the adjusting



pawl will ride over to the next tooth on the rack bar. Release of pressure permits the return spring to shorten the linkage. The pawl is held against the rack bar by two compression stop springs, operating against ears on the adjusting pawl. During automatic operation, the rack bar is held longitudinally by two holding pawls (not shown). Rack-bar rotation is prevented by a locking arrangement on the collar and spokes. *Patent 2,995,219 assigned to Symington Wayne Corp., Maryland, by Howard Winther.*



Self-Cleaning Fluid Filter

Filter for handling large quantities of contaminated fluid can be flushed during operation to clear filter surfaces of accumulated foreign matter. Contaminated fluid enters the filter assembly, which contains several tubular screens, through a slotted inlet plate and flows through the screens into an outlet passage. To flush any of the filter elements, the inlet valve plate is rotated by an external handle to block off flow into that screen. Simultaneously, a dump orifice in a plate at the other end of the filter assembly is lined up with



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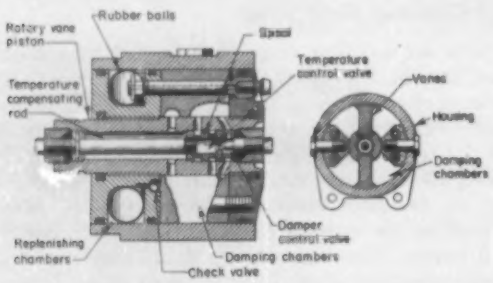
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the blocked element. Reverse flow of fluid into the filter and out through the dump orifice and port flushes the screen surface and carries the contaminant away. If the filter elements become completely plugged between cleaning operations, a check valve permits unfiltered fluid to bypass the filter assembly. *Patent 2,985,306 assigned to The Bendix Corp., by Robert W. Statzell.*

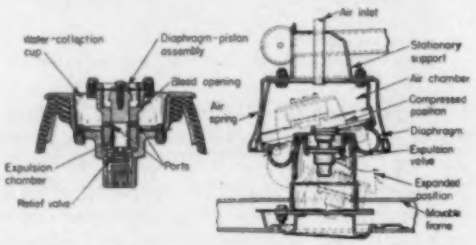
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Fluid is shuttled back and forth between opposed chambers in a rotary damper to control vibration and flutter. In the process, working fluid passes over a temperature-compensating device which adjusts a valve to compensate for changes in fluid viscosity. In operation, the rotary-vane piston is attached to one member; the damper housing to the other. When relative rotation occurs, fluid is forced from one damping chamber into the hollow core of the vane shaft, over a temperature-compensating rod, and into the opposite (180 deg) chamber. It then travels through temperature-control and damper-control valves into the second pair of chambers. As the temperature-compensating rod expands, its free end slides inside a spool to partially block an orifice, restricting flow. *Patent 2,997,140 assigned to Houdaille Industries Inc., Buffalo, N. Y., by Rollin Douglas Rumsey and William J. Carter.*



Water-Purging Pneumatic Suspension

Air-spring has built-in liquid expulsion valve that prevents excessive water accumulation under varying temperature conditions. Water that condenses in the air chamber of the spring passes into a collection cup of the valve and drains through ports into expulsion chamber. When the spring is compressed suddenly under impact load, a diaphragm-piston assembly moves downward, compressing air in expulsion



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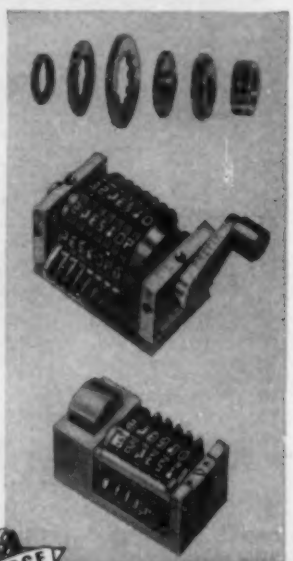
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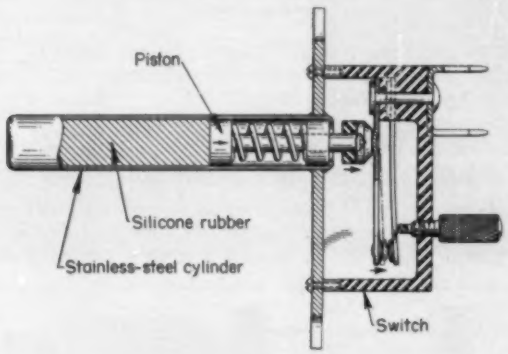
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chamber and discharging accumulated water through a spring-loaded relief valve. Expansion of spring draws air from expulsion chamber through ports which function like expansion valves to produce a cooling action. This action condenses entrained moisture, providing an additional drying effect. Bleed hole, which controls air flow to and from one side of the diaphragm, regulates pressure difference across the diaphragm and, thus, movement of the piston. *Patent 2,979,326 assigned to C. A. Norgren Co., Englewood, Colorado, by Jesse A. Wilson Jr.*

Solid-Material Thermal Switch

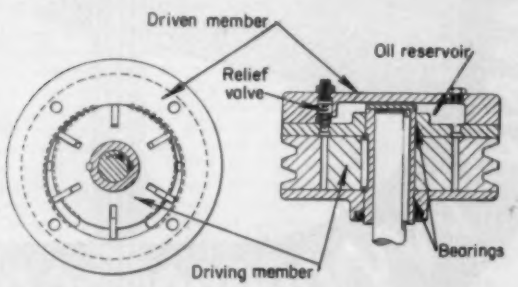
A cylinder filled with a solid, thermally responsive material is the sensing element in a thermal actuator. The material, silicone rubber or similar, is contained in a cylinder made of a material with a lower coefficient of



expansion (stainless steel, for example). When temperature rises, differential expansion causes the piston to actuate a switch or similar device. *Patent 2,990,716 assigned to Texas Instruments Inc., Dallas, Tex., by Bruce D. Butts.*

Vane-Pump Slip Coupling

Driving and driven members of a slip coupling assembly form the rotor and stator of sliding-vane pump. Mounted in an eccentric bore in the driven housing, the rotor is keyed to the drive shaft through



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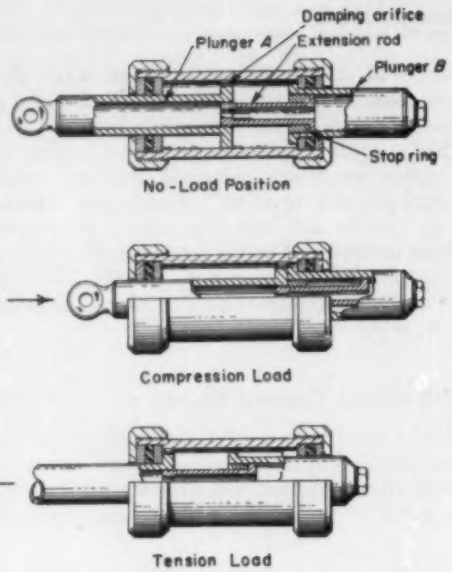
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Samuel Moore & Co.
Mantua, Ohio

Circle 420 on Page 19

loaded check valve, locking the driving and driven members together hydraulically. When fluid pressure, which is proportional to torque, reaches a prescribed level, the check valve opens, permitting circulation of the fluid and relative motion of the pump members. Thus torque transmitted to the driven member can not exceed the level determined by the valve setting. Adjustment of the valve setting is provided by a threaded plug which controls the spring force at the valve. *Patent 2,986,024 assigned to Edwards High Vacuum Ltd., Crawley, England, by Basil Dixon Power.*

Double-Acting Liquid Spring

Two movable plungers with different cross-sectional areas produce spring action under tension or compression loads in a liquid spring. Plunger *A*, which is connected to the load member, has a smaller cross-sectional area than plunger *B*. When the spring is charged with fluid under pressure, plungers *A* and *B* are moved to the no-load position; the force on plunger *B* is greater than that on plunger *A*. Under compression load, plunger *A* moves toward plunger *B* displacing its own volume and, thus, compressing the liquid in the spring. Under tension load, plunger *A* moves away from plunger *B* which is pulled along by an extension rod and stop arrangement. A volume, equal to the difference in plunger volumes, is displaced, again compressing the spring liquid. An orifice on the flange head of plunger *A* restricts fluid movement to provide damping during plunger stroke. *Patent 2,985,443 assigned to Cleveland Pneumatic Industries Inc., Cleveland, Ohio, by Ira D. Smith.*



Rotary-thrust cylinder, which operates for more than one revolution, is actuated by an explosive cartridge. Gas pressure generated by the cartridge forces a piston with internal threads against a rod with mat-

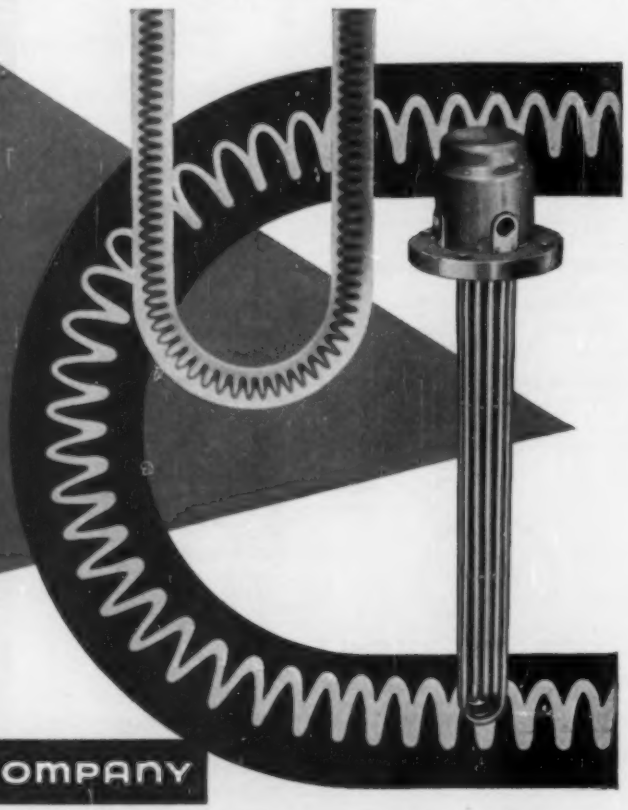
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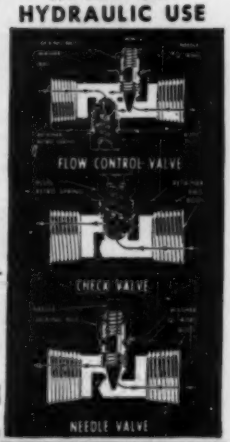


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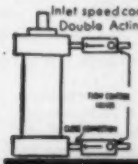
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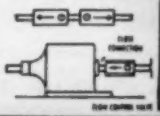
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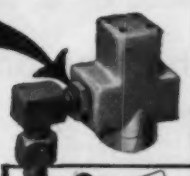
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Circle 422 on Page 19



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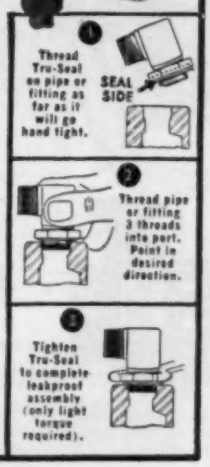
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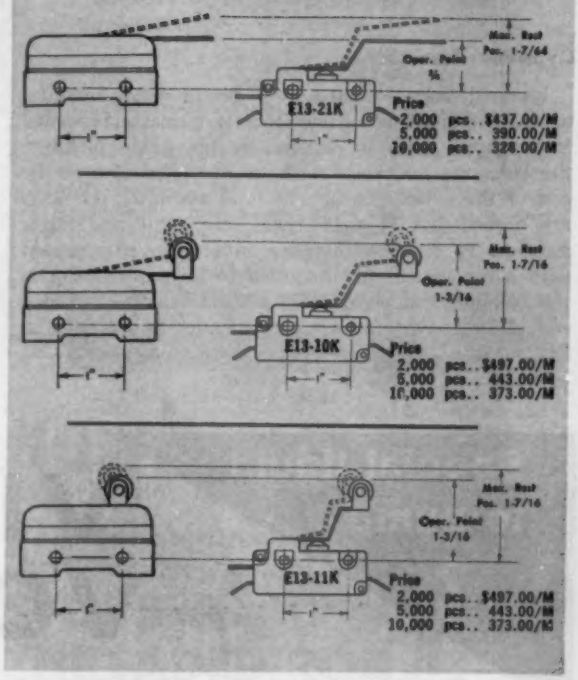


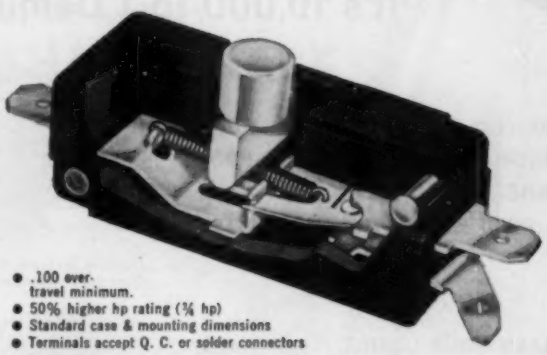
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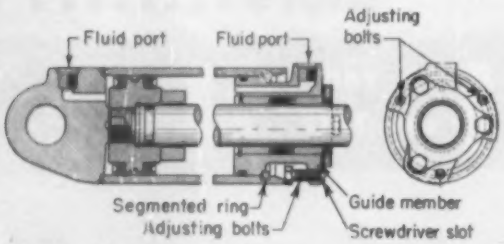
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Circle 424 on Page 19

ing external threads. The piston imparts a rotary-thrust motion to the rod, which is blocked from linear motion, via the thread coupling. *Patent 2,980,085 assigned the United States of America (Secretary of the Army) by John A. Schneider.*

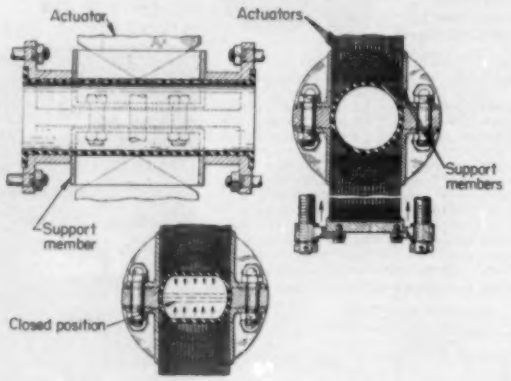


Cylinder Assembly

Inverted bolts are used in a double-acting cylinder to lock the piston-rod guide securely in place. Threaded into tapped holes in flanges on the guide member, the bolts are positioned with heads seated against the end of the cylinder wall. In final assembly, the bolts are turned out of their holes, displacing the guide member to force a shoulder into tight engagement with a segmented ring mounted in an annular slot in the cylinder wall. A slot is provided in the threaded end of the bolt to permit tightening from either end. *Patent 2,982,590 assigned to Clark Equipment Co., Michigan, by Alfred W. Gunning.*

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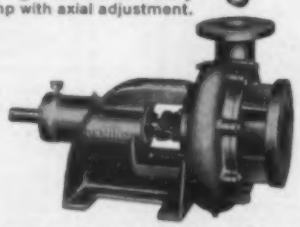
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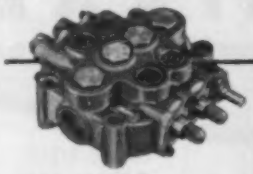
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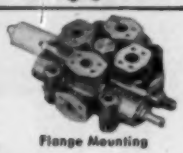
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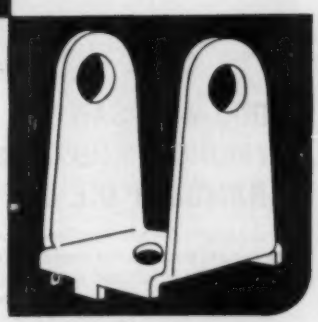


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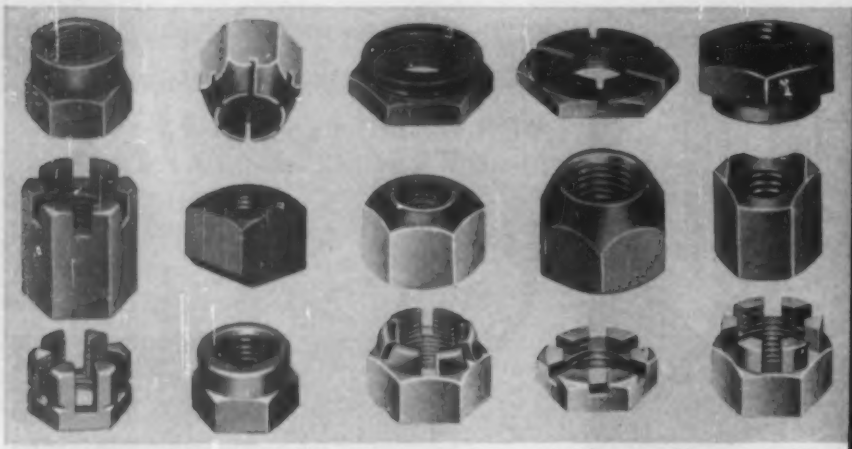


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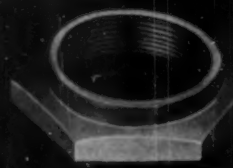
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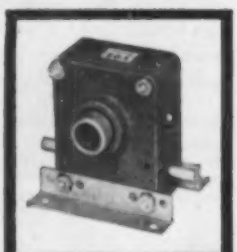
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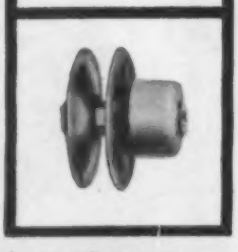
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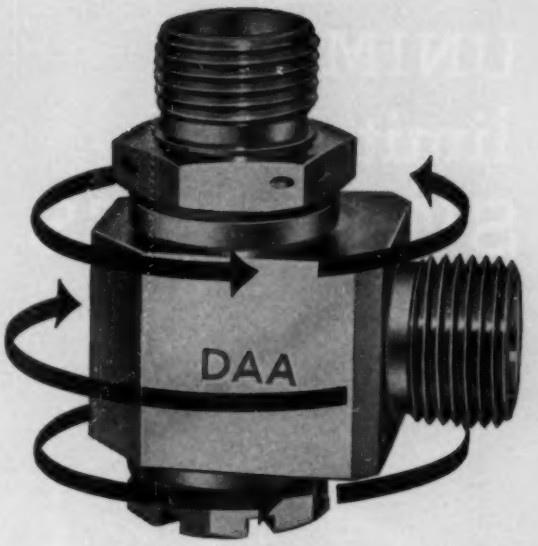
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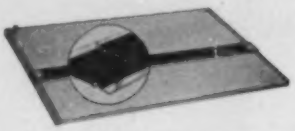
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Circle 442 on Page 19

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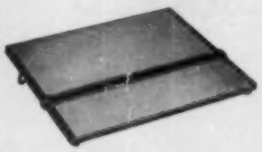


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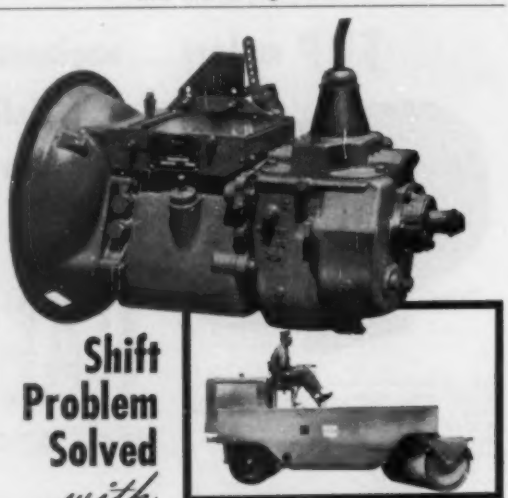
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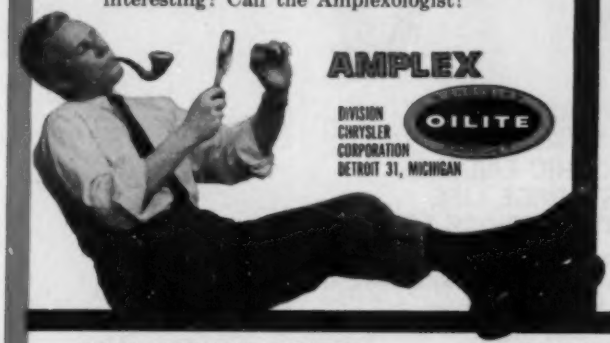
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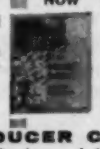


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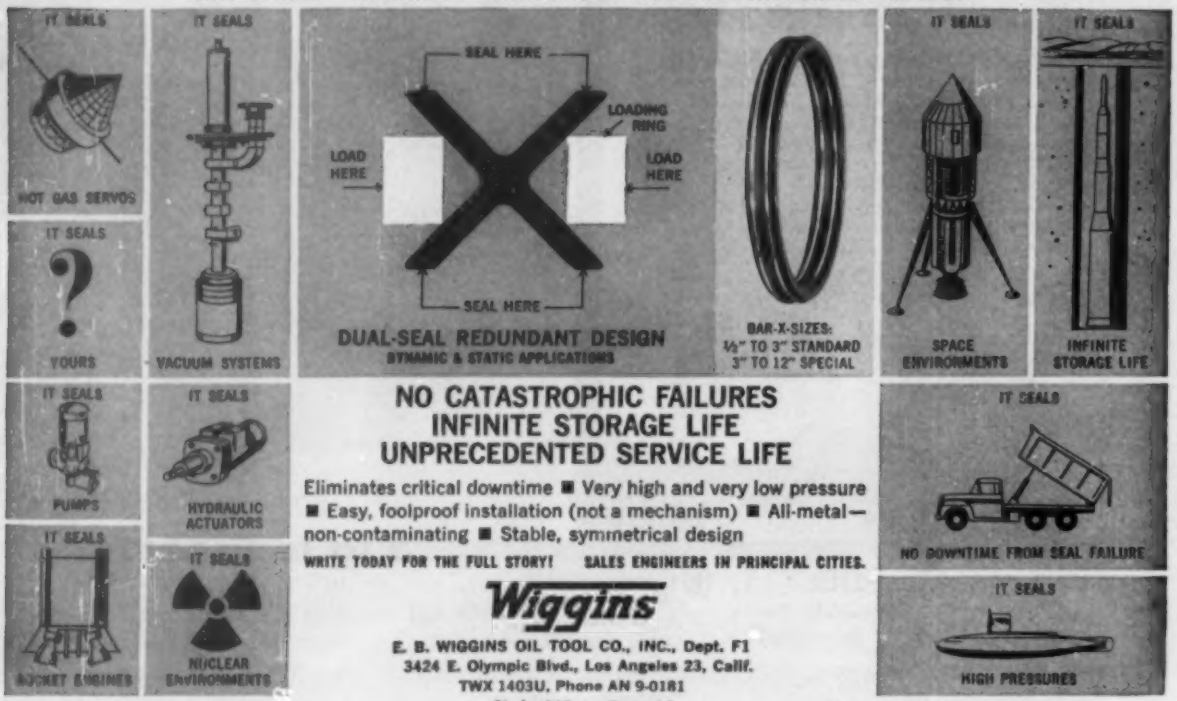
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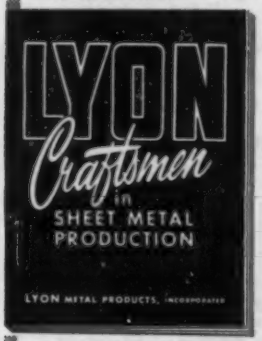
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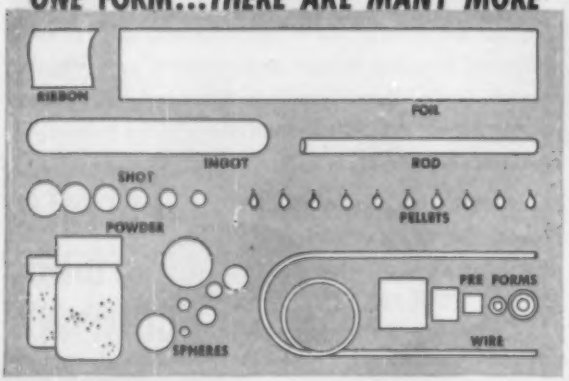


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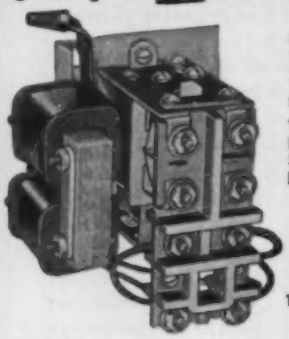
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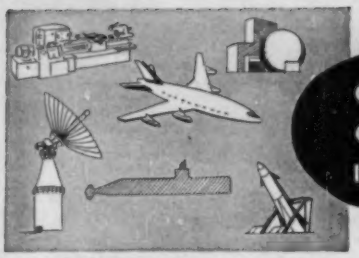
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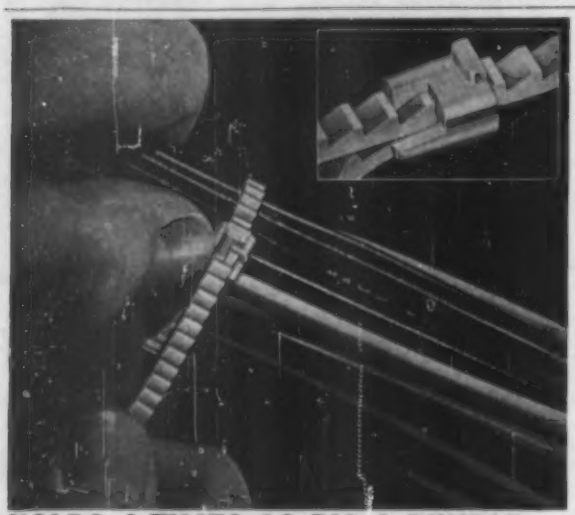
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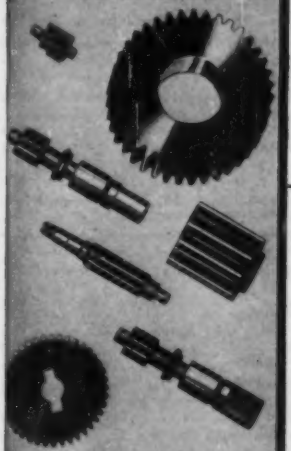
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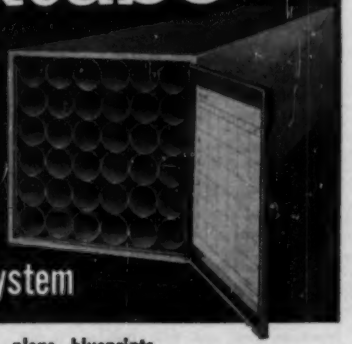
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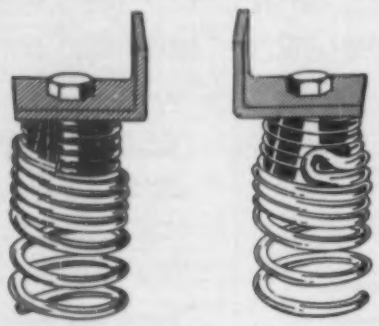
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BPA NBP

backtalk——

—Spring, Far Behind

Although we know you're a clever group, we're always impressed with a MACHINE DESIGN reader who spots the occasional error on our pages and calls it to our attention. The latest such recipient of our admiration is Mr. Milton S. Williams Jr., a range designer for General Electric Co. Mr. Williams, finding "19 Ways of Attaching Coil Springs" in our August 31 issue a "valuable refresher," studied the article so attentively that he noticed a peculiarity in the spring which demonstrates attachment by turning onto threads. It starts out as a left-hand helix and ends up as a right-hand one. "I wonder," says Mr. Williams, "what the hidden view looks like."



For those of you who came in in the middle, that's the original drawing on the left. To satisfy Mr. Williams' curiosity, we are now showing the back view, right.

—MD's Ear to the Ground

Notice that in Colin Carmichael's picture on the editorial page his right ear doesn't show at all? Well, if you want a really good look at this particular appendage to our leader's noggin, turn back to the cover. Yes, that's C. C., and he forgives all friends and acquaintances who didn't recognize him immediately.

George Farnsworth, who has such a good eye for cover material, allowed as how Colin had a good ear for it. So George asked Colin to lend him his ear—and there you have it: A fine illustration for audible signal devices.

Insofar as we know, this is as close as any of the staff has come to being a "cover boy." We hope it doesn't go to Colin's head.

—Timely Warning

If you ever ask a fellow how he's feeling and he looks at his watch before replying, don't jump to the conclusion that there's something wrong with his head. He may be using his watch as a "gout alarm," a trick employed by Kenneth L. Emmons of Wilmington, Del.

Mr. Emmons has a Hamilton self-winding watch with a gage which shows how tightly it is wound. The gage stays below 32 when he sleeps peacefully, but when he is restless—just before an attack of gout is due—the gage registers 36 or more. Then Mr. Emmons knows that it is time to take some preventive medicine.

By being a watch watcher, Mr. Emmons says he has kept ahead in the gout bout for over a year.

—Sending Saturn by Sea

The first launching of a Saturn rocket, which took place two weeks ago and is described on Page 6 of this issue, marks the beginning of American traffic to the moon. In space, Saturn is the most ambitious transportation vehicle ever; on Earth, however, it is like a whale on a turnpike. Too large to be moved by conventional rail, highway, or air transport, the eight-engine booster stage was sent from Huntsville, Ala., to Cape Canaveral by barge. Appropriately, the name of the craft that delivered it was the *Compromise*.

—Stuff and Sensing Devices

Even in the preparation of an article that is 26 pages long, it can be the little things that cause big troubles for editors. For instance: Part 1 of "Basic Electronic Controls," coming in the next issue, contains a diagram of a Wheatstone bridge circuit. The transducers in two legs of the bridge were labeled "sensing elements," which was simple enough—but what was to be done about the resistors in the other two legs? If MACHINE DESIGN style for forming words with the prefix *non* were followed, they would have had to be called "nonsensing elements." And this was considered inappropriate.

To see how our intrepid editor blue-penciled his way out of this one and to learn much about electronic controls, read the two-part article. Part 1 deals with transducers and the physical characteristics that they can measure; Part 2, in the December 7 issue, will cover indicators, recorders, and controllers.

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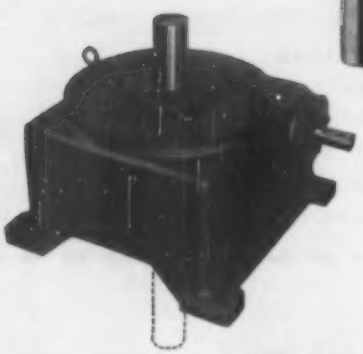
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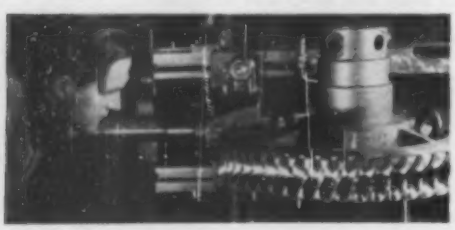
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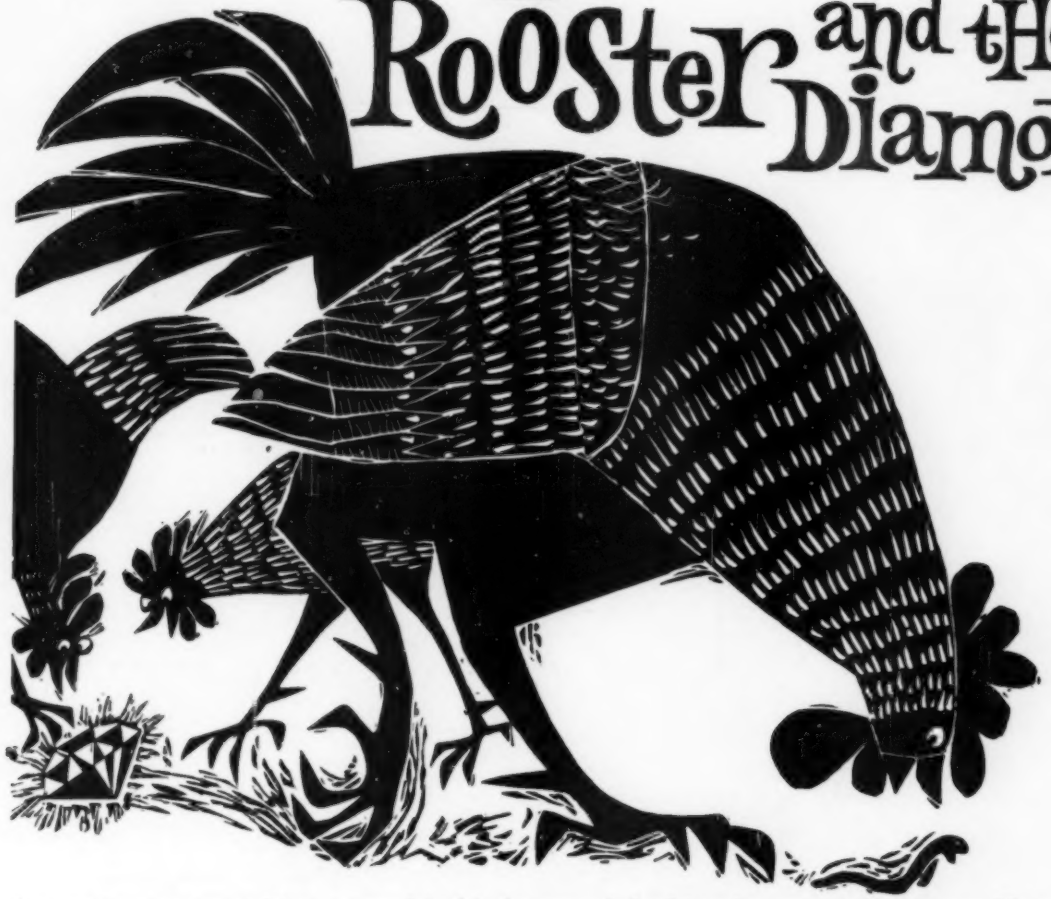


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moral: Don't let fancy outshine value.

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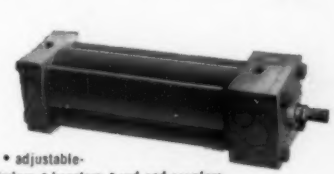
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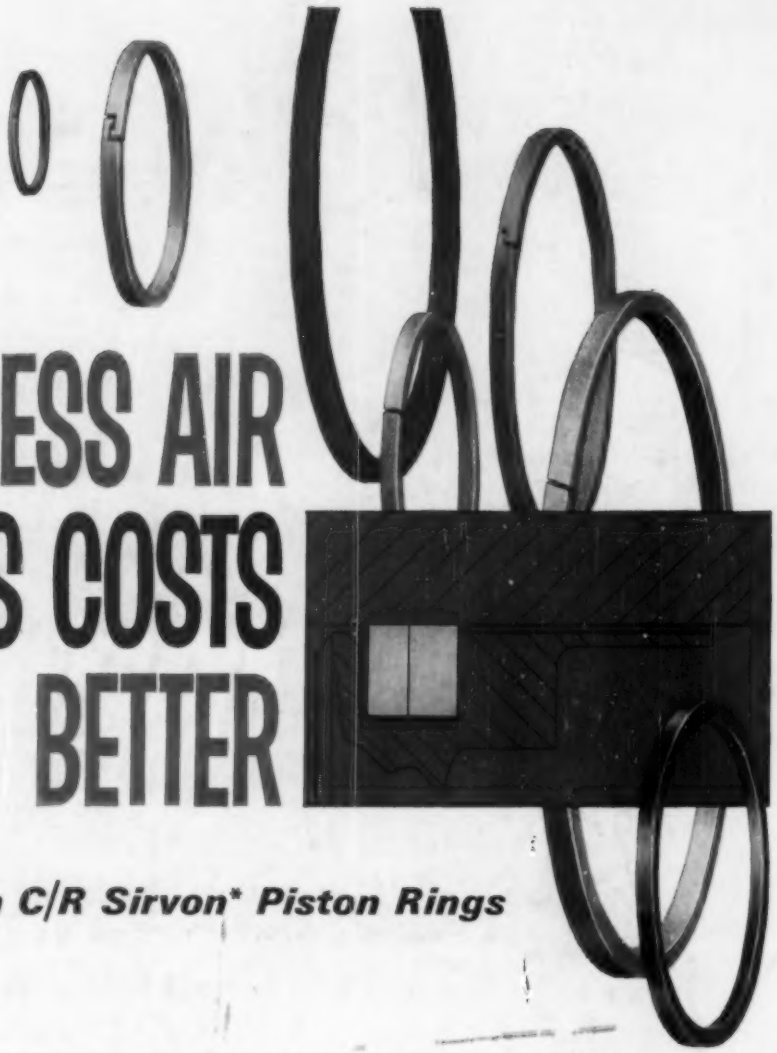
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